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RAPHAEL MELDOLA

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Prof. Raphael Meldola, D.Sc. LL.D., F.R.S.

REVIEW COPY.

RAPHAEL MELDOLA

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REMINISCENCES OF HIS WORTH AND WORK BY THOSE WHO KNEW HIM TOGETHER WITH A CHRONOLOGICAL LIST OF HIS PUBLICATIONS MDCCC LXIX · · · MDCCCCXV : EDITED BY JAMES MARCHANT

PREFACE BY
THE RIGHT HON. LORD MOULTON
K.C.B., F.R.S.

Whatever evil voices may rage, Science secure among the powers that are eternal will do her work and be blessed.

T. H. Huxley.

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PREFACE

By LORD MOULTON

Among those who have thought seriously about the present state of our nation and its future prospects, and have had the great privilege of personal acquaintance with the late Professor Meldola, there can be but one feeling as to his loss—viz., that at the time of his death he was one of the men whom England could least afford to spare. We have with us many whose influence has been wider, and others whose scientific achievements have been greater, and we admire and cherish them. But at this crisis in the history of our nation there is something which needs adding to these great qualities to meet our wants, and it was to be found in Professor Meldola. It may be said of him that he represented fully the type of intellect and personality which must be developed amongst us if this War is not to be a mere incident in a long-drawn-out decline of our national greatness. We must have leaders

and followers who, like him, are inspired with an equal devotion to knowledge and to the utilisation of knowledge.

From his earliest manhood we find him showing an ardent love of knowledge. So catholic were his tastes that he would have been in danger of becoming encyclopædic if he had not been saved by that passion for accurate knowledge which drives men to research. Hence we find him doing original work in many branches of science, all of which is sound, suggestive, and stimulating. But that to which he mainly gave his life and by which he must be judged was, of course, organic chemistry, and it is here that his character most clearly shows itself. Knowledge in itself was in his eyes of priceless value, and he spared no effort to attain it. But, once attained, it became part and parcel of himself, stimulating all his activities and shaping all his actions. There was no line of demarcation between his intellectual and his practical life. Knowledge was sought by him that ultimately it might be applied to life.

It was this which caused him to be found in his earlier years among the small but able band of industrial chemists which England then possessed, and which in happier surroundings might have successfully carried on the work that had already

been begun by their predecessors and contemporaries, and which had in truth inaugurated the great colour industry which has enriched our rivals. But the times were not propitious. The seed had fallen upon stony ground. England would have none of an industry which required its manufacturers to study science and to master facts difficult of comprehension. It chose to continue making its profits out of the older and simpler industries in which the well-nigh hereditary skill of its workmen and the abundance of its plant, however antiquated in type, enabled it to make present profits during the period when other nations were exploiting the newly created and highly remunerative chemical industries, before they had acquired capital enough or the necessary time had elapsed to enable them to attack us on our own ground.

To my mind it was little less than a calamity that Professor Meldola in the prime of his life left industrial chemistry to become Professor of Chemistry at the Finsbury Technical College. But in heart he remained an industrial chemist to the end of his life. And in truth he had no choice. Industrial chemists of his type were a drug on the market. No career was open to them, and perforce they had to take to teaching.

Under the circumstances, it was, after all, the best that they could do—to keep alive the race of English chemists until England learned to appreciate their value, even though in the meantime many went to take service in the great German chemical factories. The years he spent as a teacher were used by him for research ; and if he could not help his country because she refused to be helped, he could at least keep alive her chemical school and increase that knowledge which he loved for its own sake.

Coming generations will speculate on the causes of this insensate want of enterprise on the part of England during the last forty years. Many causes no doubt have contributed to it, but to my mind the main cause has been the quality of the education which has been given to all classes in this country. We have not brought into general working any system whereby it is made possible for the select intellects in the poorer classes to receive all the training which they are capable of using to advantage, and thus we are not only losing the occasional men of genius that might thus be found, but we are failing to obtain that large class of trained and efficient workers who are the very life and soul of technical industries. But it is the education of the richer classes that is

most to blame. The bulk of the precious hours given to education are wasted on subjects of no use in practical life. Unless he becomes a teacher or a preacher, not one boy in ten, ten years after he leaves school, remembers the Latin he learnt there, and not one in a hundred remembers the Greek. And the boys themselves know this well, and it is impossible that they should get training in mastering difficulties in practical life from the teaching that they receive in subjects that they know can only be useful in the race for school or university distinctions. Had the time thus wasted been devoted to the study of subjects depending on the laws of Nature, which are always being exemplified around us, the knowledge acquired would remain and—what is of greater importance—the study of things and not merely of words would have produced a habit of mind fit for doing its part in advancing the work of the nation.

It was in the character of industrial chemist that in the early days of the War I had the assistance of Professor Meldola in problems which were vital to the question of the supply of explosives to our Forces. But his activities were soon claimed in other directions, and it was only from time to time that I heard echoes of the work

on which he was engaged. I had, however, the comfortable assurance that wherever he was directing research the progress would be steady and sound, and that the influence of his personal charm and the infection of his patient tolerance of differences of opinion would steer it through those difficulties which sometimes arise among earnest workers at a time of great stress.

Through his whole life Professor Meldola was the champion of all that is best for England—extension of knowledge, personal devotion to work, delight in truth for its own sake, and, above all, the realisation that the crown of knowledge is its utilisation for the benefit of mankind. Thus it is that I say that England could least of all spare a man whose blameless and energetic life was inspired by such ideals.

MOULTON.

EDITOR'S NOTE

It has been a labour of love to Contributors and Editor and Publishers to gather together and issue the following tributes and reminiscences concerning the worth and work of our eminent friend the late Professor Raphael Meldola, in order to preserve the happy recollections of those who knew him best, and to record the high esteem in which he was held by his contemporaries. Any profits arising from the sales of this little book will be at the charitable disposal of Mrs Meldola.

J. M.

London, *August* 1916.

CONTENTS

PAGE

PREFACE, BY LORD MOULTON . . . v

EDITOR'S NOTE xi

BIOGRAPHICAL MEMOIR:

By Sir WILLIAM A. TILDEN, D.Sc., F.R.S. 1

EARLY YEARS:

I. By Miss NEUMEGEN 12

II. By Sir ISIDORE SPIELMANN, C.M.G. . 14

PROFESSOR OF CHEMISTRY:

I. By M. O. FORSTER, D.Sc., F.R.S. . 17

II. By Professor W. E. DALBY, F.R.S. . 23

III. By the late Professor SILVANUS P. THOMPSON, D.Sc., F.R.S. . . . 30

IV. By Professor W. J. POPE, LL.D., D.Sc., F.R.S. 33

V. By Professor E. G. COKER, D.Sc., F.R.S. 38

PAGE

CHEMICAL INVESTIGATOR:

I. By Professor Arthur G. Green, M.Sc., F.R.S., F.I.C. 42

II. By Sir T. Edward Thorpe, C.B., F.R.S. 63

NATURALIST:

I. By Professor E. B. Poulton, LL.D., D.Sc., F.R.S. 78

II. By Sir Archibald Geikie, O.M. . 112

III. By Sir F. Carruthers Gould . . 117

IV. By William Cole 119

V. By William White 123

ASTRONOMER:

I. By Sir Alexander Pedler, C.I.E., F.R.S. 131

II. By Sir Norman Lockyer, K.C.B., F.R.S. 136

PERSONALITY:

I. By Sir Joseph Larmor, M.P. . . 137

II. By Geoffrey S. Williams . . 138

III. By W. H. Stead 139

IV. By Israel Zangwill 144

PAGE

V. By Eugene Wild 146

VI. By Paul Goodman 148

APPENDICES

I. Letters of Sympathy 151

II. Official Resolutions of Sympathy and Appreciation 154

III. Bibliography of Works by Professor Raphael Meldola (1869–1915), edited by Professor E. B. Poulton, D.Sc., F.R.S. 174

PORTRAIT

Professor Raphael Meldola, D.Sc., LL.D., F.R.S. . . . . *Frontispiece*

From a photograph by Elliott & Fry.

BIOGRAPHICAL MEMOIR[1]

By Sir WM. A. TILDEN, D.Sc., F.R.S.

Raphael Meldola, son of the late Samuel Meldola, and grandson of Raphael Meldola, Chief Rabbi, was born in London, July 19, 1849.

The Meldolas came of an ancient Sephardic family, the genealogy of which can be traced through sixteen generations without a break, back to Isaiah Meldola (b. 1282, d. 1340) of Toledo.

The name Meldola seems to have been assumed by some of the family who first established themselves in Italy, at a place of that name not far from Ravenna. The Sephardim consist of the Spanish and Portuguese Jews, and form the more aristocratic section of the race. Many of them

[1] This memoir was written for the Royal Society, and is here published by kind permission.

were learned men, some practised medicine, and several wrote on mathematics, astronomy, and philology. The earlier members of the family for many generations were the Chief Rabbis of their communities.

Raphael received his early education in private schools, and entered the Royal College of Chemistry in 1866. He spent a short time as assistant in the laboratory of the late Dr John Stenhouse, F.R.S., and he then entered the colour works of Messrs Williams, Thomas & Dower of Brentford, where he remained about two years. In 1873 he rejoined the College, then transferred to South Kensington, and served for a time on the teaching staff under Professor (afterwards Sir Edward) Frankland. At this time he was attracted by the study of spectrum analysis and worked under the direction of Sir Norman Lockyer. In 1895 he was placed in charge of the Government Eclipse Expedition to the Nicobar Islands. On his return to England he was engaged as scientific chemist at the

Atlas Colour Works at Hackney Wick (Messrs Brooke, Simpson & Spiller), and there he remained eight years. At this time he made a number of important discoveries in connection with coal-tar colours, which, however, received more attention in Germany than in this country. Thus, in 1879 he discovered the first oxazine dyestuff, still generally known as Meldola's Blue. This was never manufactured in England, but was produced in large quantities in Germany, under various names. Meldola also carried out a considerable amount of research on the triphenylmethane colours, much of which, however, was never published. He was also the discoverer of the first acid green (from benzaldehyd and diphenylamine) and of the beta-naphthalated rosaniline sulphonic acid, first brought out in 1883 as Alkali Blue XG, which has recently become of considerable importance for cotton-dyeing, under the names of Chlorazol, Brilliant Blue, Isamine Blue, Brilliant Sky Blue, etc.

The investigations which he published, dealing especially with derivatives of naphthalene and with azo compounds, appeared in the *Transactions* of the Chemical Society. This work, for the most part overlooked in England, has borne extensive fruit in Germany. Disappointed by the small amount of encouragement received from his employers, he accepted in 1885 the post of Professor of Chemistry at the Finsbury Technical College, and thus relinquished direct association with the industrial applications of chemistry. He did not, however, cease to take an interest in the manufacture of dyestuffs and in the applications of chemistry to industrial purposes in general. He never lost an opportunity of pointing out the disastrous consequences which would ensue, and which, as a matter of fact, have ensued, in respect to the coal-tar dyes, from the neglect of science in this country. A paper communicated to the Society of Arts, so long ago as 1886, sounded his first note of warning. The

contention that the decline of the colour industry in England and its gradual transference to Germany were due to defects in our patent law or to the want of sufficient facilities for the use of duty-free alcohol by manufacturers he showed to be almost entirely without foundation. And he proved in many papers, lectures, and addresses that the real cause of the loss to this country was the inability on the part of manufacturers to perceive the necessity of associating uninterrupted research with manufacturing operations, not only with the view to improvements in processes actually worked, but for the purpose of continually adding new products to those at the time available.

His reputation as one of the recognised authorities on the chemistry and manufacture of dyes explains his appointment in July 1915 to the chairmanship of the Advisory Council of British Dyes, Limited. He had, however, in a vigorous and characteristic letter to *The Times* of 20th Jan-

uary, protested against the constitution of a directorate in which scientific chemistry was unrepresented.

His views on this subject can best be expressed by a few words from his last address to the Institute of Chemistry, on March 1, 1915. "I repeat," he said, "it is not a business question, but a chemical question, and it is by chemical research alone that our colour industry can be saved in the long run. Consider the leeway that we have to make up. The German colour industry has been built up by the utilisation of the results of research carried on in the factories and universities and technical schools for a period of over forty years! To suppose that we can retrieve our position after forty years of neglect by starting a Company the directorate of which is to consist solely of business people is simply ludicrous." Again, later: "The group of industries which have arisen from the products of the tar still are not going to remain stagnant after the war, and

it is scientific guidance and not mere assistance that will keep them alive. It is the expert, and the expert only, who can foresee the course of development, who can keep in touch with the progress of research, and who can direct with intelligence the campaign against our competitors. If such scientific direction is withheld, all schemes are sooner or later bound to end in failure. I deliver my second warning to a new generation after an interval of about thirty years ; if it is again unheeded, so much the worse for the country ! "

As Professor at the Finsbury College, where he held office from 1885 till his death on November 16, 1915, Meldola was indefatigable as a teacher, and in promoting the welfare and advancement of his students after leaving college. Of his success in this direction there is evidence in the fact that several of his past pupils became Fellows of the Royal Society and occupy university chairs. It is interesting in this connection to notice that the place left vacant at

Finsbury will be occupied by a former student of his own, Professor Gilbert T. Morgan, F.R.S.

Meldola's scientific chemical work related chiefly to synthetic colouring matters, and, as already mentioned, is recorded chiefly in the *Transactions* of the Chemical Society. But he was also an authority on photographic chemistry, and published a book on the subject in 1891. In 1904 he published, under the title "The Chemical Synthesis of Vital Products," the result of several years of laborious compilation. He was, however, not a chemist only, for his earliest studies led him in quite a different direction, and it would seem that his own inclinations wavered between chemistry, which became his professional occupation, and natural history, which filled his scanty leisure.

The first six papers under his name in the Royal Society Catalogue relate to biological subjects, among which is prominent the protective mimicry found among insects. This subject he pursued with success, and, after

taking a leading part in starting the Essex Field Club in 1880, he became President of the Entomological Society in 1895.

In 1882, encouraged by Mr Darwin, he published a translation of Weismann's "Studies in the Theory of Descent."

During the latter part of his life Meldola gave much time to the work of the several societies connected with chemistry. In turn he became President of the Chemical Society (1905–7), the Society of Dyers and Colourists (1907–8), the Society of Chemical Industry (1908), and the Institute of Chemistry (1912–15). With regard to the last-named institution, Meldola, though one of the original Fellows, was not at first enthusiastic about the Institute and its work, but in course of time he became convinced that it had a public mission to fulfil of the same order of importance as that discharged by other bodies of professional men. As President, at the end of his first year of office he used the opportunity to acknowledge this alteration of his views.

He was also instrumental in arranging a conference of professors of chemistry and other teachers with the object of bringing the training and examinations prescribed by the Institute for its Associates into more harmonious relation to the work of the Universities; and there can be no doubt that this closer connection will hereafter operate beneficially on all the institutions in which young chemists are educated with a view to the practical application and utilisation of their knowledge.

Meldola received many scientific honours. He was elected into the Royal Society in 1886. He served twice on the Council of the Society (1896–98 and 1914–15), and in 1914 was appointed a Vice-President. He had been nominated again for a seat on the Council for the year 1915–16 shortly before his death. In 1910 he was awarded the honorary degree of D.Sc. by the University of Oxford on the occasion of his Herbert Spencer Lecture; he also received the LL.D. of St Andrews in 1911.

The Royal Society awarded him the Davy Medal in 1913.

In 1886 he married Ella Frederica, daughter of the late Dr Maurice Davis, J.P., who survives him.

His end was quite sudden and may be ascribed, with great probability, to the effect of overwork following on an illness which in the previous spring had involved a troublesome surgical operation. But Meldola was not one to spare himself when he heard the call of duty, and since the outbreak of war his work on various committees had been incessant.

It would not be easy to do justice to Meldola's personal character, on account partly of his natural modesty, partly of his many-sidedness. He was a good chairman, always clear, judicious, tactful, and good-humoured. His friendships once formed remained unbroken through long years to the end, and this is perhaps the best testimony to the quality of his heart.

REMINISCENCES

EARLY YEARS

I. By Miss NEUMEGEN

Raphael Meldola was at Gloucester House School, Kew, with my father from the age of seven and a half years to about fourteen, and although it was many years before co-education was in vogue, a school for girls conducted by my mother being under the same roof, I had many opportunities of coming into contact with him. He was a very gentle and courteous boy. My father used to say that he spent all his recreation time in summer hunting for "specimens" in the pasture lands and market gardens which in the early 'sixties made Kew a rural village, and not, as now, a suburb of London.

I also remember a holiday at the seaside when I often joined a party of boys of which he formed a member, when he also spent

his time searching rocks and cliffs for "specimens."

He showed his scientific bent at a very early age. I remember my mother saying, as she looked through some prize books for the boys: "Surely this scientific book is far beyond any of the boys." "Oh no," answered my father, "I bought that for Meldola; that is all he cares for."

When at school he was inordinately fond of cats, and I have heard that his nickname was "Puss." My mother used to relate that upon one occasion, when he was being examined on account of some slight indisposition, she was alarmed because he apparently could not raise his right arm. After a little gentle persuasion he lifted it gingerly and disclosed the head of a little kitten nestling there.

When he came to say good-bye to my father, on his appointment as head of the party sent out by the Royal Society to the Nicobar Islands to observe the total eclipse of the sun, I remember, as a young girl, being

struck by the extreme modesty and simplicity he displayed when he had just been chosen for such a distinction.

II. By Sir ISIDORE SPIELMANN, C.M.G.

MELDOLA'S FIRST LECTURE

I first met Raphael Meldola about the year 1864 at a boarding-school kept by his relative, the Rev. A. P. Mendes, at Northwick College, Maida Vale. He was one of the big boys, and I one of the younger boys. He was studious, and I fear I was lazy.

My first recollection of his ability was when he lectured to the boys of the school one evening on chemistry, which he was to make his profession. It was his first lecture. The occasion was a great one, the parents of all the boys being invited. I was never so surprised as when young Meldola, (he could not have been more than fifteen), lectured like

a professor. He was calm and dignified, neither his voice nor his manner betraying the smallest nervousness, and from the first word he uttered he appeared to have secured the close attention of all present. No doubt the lecture was of a very elementary character, but when he commenced to show practical illustrations, such as suddenly converting what appeared to be a glass of water into a liquid resembling claret, the boys were as impressed as if he had been a conjurer, and the applause was terrific.

Meldola was already a great scientist in our eyes. I regarded him henceforth as a professor of the first rank, and I rarely had the courage to address him with less respect than I did the Principal of the College.

I think, but am not quite sure, that Meldola disliked games. I cannot remember him attending our games of cricket, which were always played on Wednesday afternoon at Primrose Hill, and this appears to have made a favourable impression upon the Principal. I remember perfectly well that,

when this epoch-making lecture in Meldola's life was concluded and Mr Mendes proposed a vote of thanks to him, he said that the ability of young Meldola was no doubt due to his constant attention to his work, and because he did not participate in games! A headmaster would not make such a remark nowadays, but fifty years ago importance was not attached to games as it is to-day.

Although I rarely met Meldola till some twenty years later, I followed his remarkably successful career with great admiration, and read of his successes with keen appreciation. When later my acquaintance with my clever schoolfellow was renewed, I felt it to be a very great privilege and almost a condescension on his part. I knew that he was reaching the crowning success of his life when he was elected President of some of the representative scientific societies, and I feel now that, had he been spared, still greater honours and recognition would have been his. Death deprived him of them, but few deserved them more.

PROFESSOR OF CHEMISTRY

I. By M. O. FORSTER, D.Sc., F.R.S.

To embrace an opportunity of paying a tribute of respect to the memory of the late Professor Meldola must be not only an obligation but a satisfaction to one of his oldest students.

I saw him first in the autumn of 1888, when, scarcely sixteen, I entered the Chemistry Department of the Finsbury Technical College, and it was two years later, on admission to his research laboratory, that I began to know him ; but the full value of the training he imparted, the love of organic chemistry which compensated for inadequate material equipment, and the absorbing interest which he took in the problems we were set to solve, could only later be appreciated. This genuine and living interest in his work was contagious, and it is a matter of agreement amongst those of his students privileged to work in close

association with him that it formed one of the most valuable features of his instruction in research methods ; he shared our boyish delight in the little successes, and encouraged us philosophically in the little failures. Moreover, he was extraordinarily patient with our little stupidities, and the only thing which angered him was any sign of disinclination to take the work seriously. In this he was fully justified, because, although inadequacy of resources in regard to laboratory accommodation, number of assistants, and limitation of their training prevented him from undertaking branches of investigation which were both ambitious and *programmässig*, he had the great gift of selecting problems of sufficient interest and importance to command close attention, whilst presenting difficulties within the capacity of an ordinary student, working under his guidance, to overcome.

Organic chemistry is peculiarly adapted to instruction in methods of research. In the course of his labours the student is called

upon to study the writings of previous workers in the same domain, to prepare some of the materials which they have prepared, to compare his own manipulative skill with theirs, to test the quality of his own preparations by the standard which they have established, and, should he discover compounds which do not already appear in the literature, to exhaust all the known methods of chemical identification and literature-search before deciding that these compounds are really new. All these operations try his patience, industry, and manipulative experience; they teach him to face disappointment and triumph with equal dignity. He has the opportunity to acquire the elevating spirit of the pioneer, accompanied by a sense of responsibility and a determination that any new fact which passes into the indelible records of scientific literature under his name shall at least be capable of withstanding, at the hands of his successors, the rigid tests which he himself has applied to the work of his predecessors. Even if the actual new

facts at which he arrives are comparatively unimportant, mere bricks in the huge and growing edifice of accumulated knowledge, these invaluable qualities may become part of his character, and enable him to attack, with some hope of success, and with cautious confidence in the accuracy of his observations, those problems—usually remote from chemical study—with which he is confronted in subsequent stages of his career.

Meldola recognised and utilised this particular attribute of organic chemical research, and throughout the exercises which he set, we had the feeling that he was a collaborator, not a taskmaster. Herein lay the great value of his work as a teacher, because then he was one of ourselves, an older student with far wider views and much riper experience. In the ordinary work of the main laboratory and in the lecture-room he was, in those days, less successful than he deserved to be, and this I ascribe to a certain shyness which clung to him for many years, and which probably arose from the considerable

period of his early career which had been spent out of contact with student-life. On at least one occasion in each year, however, he was more adequately appreciated by his former students ; this was the annual dinner of the Chemistry Department, which owed its inception and continuance to Mr Harley F. Knight. It gave the Professor unaffected pleasure to preside at this gathering, and in the freedom from academic restraint, and with a large fund of old acquaintanceships with common experiences upon which to draw, his *camaraderie* and sense of humour had full play. It has always appeared to me that his more human characteristics were displayed at their best on these occasions, when he clearly felt, as we felt with him, that he was the intellectual father of the assembled children. Many of his younger pupils left these meetings with a new feeling of warmth for their former teacher, and with deeper respect for his real service to chemistry.

One characteristic of the Professor which

came as a perpetual source of surprise to most people was the clearness and vigour of his enunciation. In a man of such frail appearance—for even thirty years ago he gave the impression of delicate health, and suffered then from the troublesome cough which never seemed to leave him—it would have been excusable to find him economising energy, but the will to do was too strong. Consequently his addresses, well constructed and thoughtfully written, were not only illuminating to read but were stimulating to hear ; his voice, clear, strong, and well controlled, gave due effect to every point. In the less formal oratory which prevails after dinner he was also extremely fortunate, and was always a welcome guest at the Worshipful Company of Dyers and those other City Guilds which contributed to the maintenance of the Institute.

In all such addresses it is easy to detect a strong guiding principle, namely, an ardent desire for the advancement of science, and particularly chemical science. Thirty years

ago we find him speaking with courage and lucidity on British neglect of science and its application to industry. Continuously, fearlessly, and forcefully he preached that gospel, and his last presidential utterance was upon the same subject. He lived to witness the fulfilment of his worst fears, but before his death a gleam appeared in the sky ; whether this may be the presage of dawn it is yet too early to determine, but in any event his memory will remain dear to his associates as that of a man who fought the good fight.

II. By Professor W. E. DALBY, F.R.S.

Raphael Meldola was my friend for twenty years. For eight years we were colleagues at the Finsbury Technical College. I taught Meldola's students mathematics and engineering, and he taught my students chemistry. Meldola held strongly that

engineering should be included in the training of chemists intending to proceed to practice in the chemical industries of the country.

To know Meldola was to know a personality. In any assembly of men he was intellectually conspicuous. He had the faculty of making friends amongst all conditions of men, and he won their esteem, their respect, and their admiration by the unconscious exercise of his friendliness, his sincerity, and his powerful intellect.

Many wrangles and discussions have we had together. But wrangles with Meldola were always interesting. He intrigued you with the variety and unexpectedness of his knowledge and by the facility with which he could marshal facts and bring them to bear with the swiftness and deadliness of a practised dialectician. He had read widely in English literature and was a master of apt quotation ; but what made his companionship in and out of College so attractive was his unfailing good temper and his alert sense

of humour. He saw humour in the most exasperating things, and by a few humorous remarks would at once throw irritating trifles into their proper perspective.

Meldola never obtruded his profound knowledge of chemistry on his friends. To get him to talk of chemistry was as difficult as to get an army officer to talk military shop. Sometimes I started him talking on a phase of chemical research, and then he was fine. He appeared to have had a hand in all the outstanding scientific controversies of the last forty years, and the range of his knowledge, the diversity of his interests, and the variety of his experiences were surprising. He told me one day that he was admitted to the Royal Society not as a chemist but as a biologist, and moreover that Darwin himself had signed his certificate. This from a man who stood so prominently before the scientific world as a leader of chemical research was rather astonishing. Another surprise was to find that in his youth he

had gone on an eclipse expedition, so that astronomy, too, had more than a passing attraction for him. His public-spirited work in connection with the re-establishment of the boundaries of Epping Forest should be remembered with gratitude by all dwellers in the Forest region. His unstinted help in all educational schemes for technical and general education may be mentioned as an example of his unselfishness when the good of the community was concerned.

He was eminently practical in his views. His early training in a chemical works had put him in touch with problems of manufacture and problems of chemical engineering, but his scientific spirit was in advance of the times in England. His discoveries and developments were received with coldness and apathy. "Meldola Blue" was exploited in Germany to the great benefit of the firms producing it, but it was neglected in England. Meldola finally abandoned the Works and entered the Technical College,

Finsbury, where he found scope for the development of his powers of research.

The success of Meldola's students is witness to his gifts as a teacher. His scientific papers and scientific writings are witness to his profound knowledge of industrial chemistry. His elections to the presidencies of the chemical societies of this country almost in successive years witness to the authoritative position he won amongst the chemists of his own land. Recognition came freely from foreign governments : from the Government of his own country, none. He did not crave it, but it fills thinking men with profound despondency to find how little the official classes of the country know of the men of the country ; how little they know of the resources of the country ; how little they study the industries of the country ; and how little they shape the education of the country to meet the competition of trained intellect growing up around us in other nations.

Meldola's views of the tendency of passing

things have turned out to be only too true. He had a wide and exact knowledge of the growth of the chemical industries in nations in competition with us, and he knew how increasingly we were becoming dependent on them for chemical products. His warnings can be read in his writings and addresses, but they were unheeded. Yet he had a profound belief in the possibilities of the future. With regard to the war he was an optimist ; he never wavered in his belief of ultimate victory to the Allies, and devoted all his energies to helping the Government out of its difficulties.

All who knew him realise what an irreparable loss our country has sustained by his death at a time when his profound knowledge of matters vital to the success of the war would have been so helpful.

Meldola made himself just as interesting to children as he did to his scientific friends. I know some young people who always looked forward to his visits, having collected for him various kinds of insects and creep-

ing things in which he contrived to interest them. He could spin the most fanciful yarns, and if he had ever tried I believe he could have written a book rivalling even "Alice in Wonderland."

Although Meldola ranked with the first intellectuals of his country, he was a man of simple character. He was helpful to his friends in many unobtrusive ways. His word could be relied upon absolutely. He never harboured malice, and bore ill-will to no one. He is held in affectionate remembrance by many friends.

III. By the late Professor SILVANUS P. THOMPSON, D.Sc., F.R.S.

Speaking at the Memorial Meeting of the Maccabeans, Professor Thompson said :—

"It would be impossible for one who has been associated with Raphael Meldola as I have been, to speak of him without emotion. From 1875, when I was a student at the Royal College of Science, he was my personal friend ; and for the last thirty years he was my colleague on the staff of the City and Guilds Technical College at Finsbury. Better friend no man could desire. Better and truer colleague no man could ever have. In daily association with him as a teacher, his companion in many country walks and expeditions, I had innumerable opportunities of learning what a clear and well-stored mind was his ; how rich and many-sided was his nature ; with what a wide outlook he was endowed. Whether botanising in the New Forest, cave-hunting in Yorkshire, or joining in rambles in

Epping Forest, he was ever the pleasant companion, the alert explorer, the illuminating comrade.

"With what patient assiduity, day after day in his laboratory, he toiled at the chemical syntheses which might have enriched him had he sought after money rather than after science! Keen in investigation, he was as thorough as he was keen. He was no paper chemist; indeed, he exhibited a curious contempt for the chemical investigator whose knowledge was only second-hand. If occasionally he was impatient, it was but a passing mood aroused by some pretence or superficiality of which he himself was utterly incapable. And how he spent himself for others let his students, and all with whom he was associated in the many scientific societies which he adorned, and in the meetings of committees and councils, declare. Convinced of the usefulness of association and collaboration in promoting the progress of science, he was an unwearied collaborator and an unselfish helper. With

a wide experience of men and things, he was a steadfast counsellor of resource and quiet wisdom. Those of us who were present at the deeply impressive ceremonial of last week, when we laid to rest all of him that was mortal, recognise what a true friend we have lost. Few men can have been more beloved than he. He was a man who had no axe to grind, no personal ambitions to serve. Ambitions he had, and they were very strong and deep, for the due recognition of science, for the advance of scientific education, for the success of his pupils, least of all for himself. Successor in his professorship he may have, but none can ever fill his place. While the memory of him survives he will still live on in our hearts. We shall mourn for him for many days."

IV. By WILLIAM J. POPE, LL.D., D.Sc., F.R.S.

(Professor of Chemistry in the University of Cambridge).

Some thirty years ago, as a lad of sixteen years of age, I was entered as a student of chemistry under the late Professor Meldola at the Finsbury Technical College ; for the first year or so I had little to do with the Professor, but, during the second year, I attended his lectures on organic chemistry. This course, which has proved a source of inspiration to many, introduced me to the subject which has occupied many of my later years ; the lectures were admirably designed, not only to impress the hearer with the intensely logical manner in which organic chemistry has been developed as a science, but also to indicate the directions in which further amplifications might be expected to occur. Professor Meldola was probably too earnest a student of organic chemistry to be an eloquent lecturer, but he possessed the art of presenting a strong

picture of his subject, an art which arose from his own wide knowledge, experience, and convictions.

During the last thirty years my relationships with Professor Meldola have continuously multiplied ; the respect which the student naturally feels for his Professor gradually merged into the affection and esteem gratefully expressed towards an old and valued friend. No one of the students who served under our late chief owes more to him than I do myself, and, probably on that account, no one of them feels more difficulty in writing an adequate appreciation so soon after his premature removal from our circle.

The task of describing Professor Meldola's scientific work in the present volume has been entrusted to others, and I may therefore confine myself to dealing with other and perhaps less formal aspects of the activities of our late friend and master. For the last six or seven years I have had the privilege of spending numerous, though scanty, holidays in the company of Professor

and Mrs Meldola, and of one of their oldest friends, Mr W. H. Stead of Reigate. Upon a holiday the Professor was a delightful companion ; he possessed a remarkable and detailed knowledge of the geology and archæology of the most remote districts in our island. He had hosts of friends everywhere. I have never met anyone who possessed his faculty for suddenly recollecting, in some out-of-the-way place, that a friend of his lived a few hundred yards away, or who, on presenting himself with a small retinue of followers, was received and entertained with such spontaneous cordiality and obvious pleasure. On one of these occasions I was taken to see Alfred Russel Wallace a few months before his death ; Wallace and Meldola were clearly old and intimate friends, and both, in their joy at meeting again, chatted and joked like schoolboys.

Those who were not intimately acquainted with Professor Meldola may perhaps be surprised to be told that he had a very keen appreciation of humour. On occasion

he would recite long passages from the "Ingoldsby Legends," from Bret Harte, or from some one of many other writers whose particular vein of humour had, at some time or other, struck his fancy ; he had a copious fund of anecdote largely drawn from his early experience in chemical works and especially illustrative of the peculiarities of the British workman. In this respect he was indeed a true Cockney—deeply impressed by the realities of life, but keenly sensible of the ludicrous side of any situation which might arise. His mastery of English and Scottish dialects, only occasionally exhibited in the recital of some delicious absurdity, was entirely surprising.

Professor Meldola had deeply at heart the advancement of organic chemistry, and, as every student of the subject knows, he has left his name written large on important branches of the science. He seemed, however, to regard this, the extension of scientific knowledge, as only one of several important objects of his care ; his own steady output

of valuable contributions to our knowledge of organic chemistry was, as it were, merely the recognition of the fact that every scientific man should do something to justify his existence—that he should, since money has been expended on his training and upkeep, add something to the accumulation of knowledge as a kind of dividend paid on invested capital. But, in addition to paying a handsome interest on capital expenditure by his own additions to scientific knowledge, Meldola neglected no opportunity of creating fresh capital for the enjoyment of the scientific community. His efforts to provide a magnificent home for the Institute of Chemistry were splendidly successful—they left a void in the purses of himself and many others — and, but for him, this asset to British chemistry would now be non-existent. In a host of other ways Meldola contributed largely to the expansion of the permanent establishment of chemical science as distinguished from his other prime interest, the increase of chemical knowledge.

The death of Professor Meldola must be counted among our war losses. Although his delight in natural history studies took him much into the open air, and although he was an excellent walker, he was not very robust, and probably never had much strength in reserve as a support to his intense mental activities. At the time of his death he was devoting far more energy to the cause of his country than a comparatively fragile constitution could afford.

With the passing away of our old chief we former students of Professor Meldola have lost a sound teacher, a wise counsellor, and an honest and devoted friend.

V. By Professor E. G. COKER, D.Sc., F.R.S., M.Inst.C.E.

In an age of ever-increasing pressure to specialise in some small department of science, the work and achievements of Pro-

fessor Meldola are specially remarkable for their great variety and breadth of interest, and his death removes from our midst a man of science and affairs whose loss will be felt severely in many fields of activity. Meldola was a great figure in the world of chemistry, and his eminence was recognised by all his scientific colleagues, who alone could form a just estimate of the value of his work in that field. At the City and Guilds College, Finsbury, he laboured as Professor of Chemistry for thirty years with remarkable success, and with a devotion to pure and applied science which was as intense at the end of his career as at the commencement. He was justly proud of the success of the chemical school which he had built up, and of the fact that, with somewhat meagre resources, he had trained quite an array of chemists of conspicuous ability.

Meldola was not only a chemist of rare distinction, but an eminent naturalist, and one of the great joys of his life was to spend

part of his leisure in the country in the pursuit of natural knowledge, and especially in his favourite study of insect mimicry, on which he was a foremost authority. His wife was frequently his companion on these excursions, and many of the specimens in the "Meldola Collection," now in the University Museum at Oxford, were found by her.

In another field, that of archæology, Meldola did much valuable work, especially in connection with Epping and Hainault Forests. He was a moving spirit in important investigations concerning the ancient earthworks of Loughton and Ambresbury Camps, and he rediscovered and identified the ancient boundary stones of Waltham Forest, which, under his direction, were re-erected in their original positions.

He became a Fellow of the Royal Society at the age of thirty-six, and was a Vice-President at the time of his death. The Athenæum, as a special mark of distinction, elected him a member under Rule II. ; and

he was the recipient of a great many well-deserved honours both at home and abroad.

Meldola was a warm and trusty friend and colleague, and a delightful companion. His brilliant and original mind harboured no ungenerous thoughts, and he was always entertaining and talked with rare discernment. The little gatherings at lunch of the three colleagues were a great pleasure in life at Finsbury during my ten years there, for Meldola and Thompson, friends and colleagues for thirty years, were both brilliant conversationalists, and in touch with all the great events of the scientific world. In social life Meldola was very popular, and was a delightful host and guest; and Mrs Meldola's graciousness and charm will always be remembered by their exceedingly large circle of friends.

Meldola's very considerable ability as a man of affairs was much in request by all the principal chemical societies and organisations, and he laboured for them freely. The War brought even more responsibilities of

this kind, and in spite of a serious illness during the last few months, he died in harness, working to the very last in his great desire to advance the interests of his country and of chemical science.

CHEMICAL INVESTIGATOR

I. By Professor ARTHUR G. GREEN, M.Sc., F.R.S., F.I.C.

Amongst Meldola's manifold activities, chemical research throughout his life played the greatest part. He was above all a chemist, and other scientific pursuits were more in the nature of relaxations from the serious business of life in which his main interests were centred. His chemical researches extend over a period of forty-one years, during which time he published upwards of 120 papers, notes, and monographs,

embracing a wide range of chemical subjects. These researches entitle him to a high place amongst the great chemists of the nineteenth century.

His activities as a chemical investigator fall into three periods :—

1870–1872. Chemist to Messrs Williams, Thomas & Dower.

1877–1885. Chemist to Messrs Brooke, Simpson & Spiller.

1885–1915. Professor of Chemistry at the Finsbury Technical College.

Technical Researches. — Leaving the Royal School of Mines in 1870, Meldola entered upon his first post at the works of Messrs Williams, Thomas & Dower, dyestuff manufacturers, of Brentford, the predecessors of the present firm of Williams Bros. & Co. of Hounslow. We have little record of his work during the two years of his employment at Brentford, except an account by himself of how he prepared large quantities of ethylene dibromide with the object of investigating its action on Rosani-

line base, in the hope of obtaining a violet dyestuff. It is interesting to note that on leaving these works his place was taken by Dr Otto N. Witt, another pioneer of the dyestuff industry, who later became professor of chemistry at the Technische Hochschule, Charlottenburg, and died in Berlin last year. After an interval of a few years, in which Meldola engaged in teaching work and also took charge of the Government Eclipse Expedition to the Nicobar Islands, he re-entered manufacturing chemistry, accepting in January 1877 the post of research chemist in the laboratory of Messrs Brooke, Simpson & Spiller of Hackney Wick (the successors of Simpson, Maule & Nicholson), who then occupied the position of the premier dyestuff firm in England. During the period of eight years in which Meldola was connected with this firm, he carried out a series of important technical and scientific researches and made many valuable discoveries, the full results of which, however, were unfortunately never realised in this

country. Thus, in 1879 he discovered the first dyestuff of the "Oxazine" class, still generally known as "Meldola's Blue." This colouring-matter, obtained by the action of nitrosodimethylaniline upon beta-naphthol, was not introduced into commerce in England, but was soon manufactured in large quantities in Germany under the names of Fast Blue, Cotton Blue, Naphthol Blue, etc., where it led to the discovery two years later of the still more important Gallocyanine Blues by Koechlin. Another method of obtaining oxazine dyestuffs, published by Meldola in 1881, and consisting in reacting with a nitrosophenol upon an amine or diamine, was utilised later in the preparation of Nile Blue by Hoffman and Weinberg (1890) and of Cresyl Blue by Bender (1892). Meldola also carried out a considerable amount of work on the triphenylmethane dyestuffs, much of which was never published, but reposed in the archives of the laboratory, now unfortunately lost. He was the discoverer of the first "Acid" Green, known

as Viridine (1878), obtained by sulphonation of the condensation product of benzotrichloride and diphenylamine ; also of the beta-naphthylated rosaniline sulphonic acid, first brought out by Brooke, Simpson & Spiller in 1883 under the name of Alkali Blue XG, and which has since become of considerable importance in cotton-dyeing under the names of Chlorazol, Brilliant Blue, Isamine Blue, Brilliant Sky Blue, etc.

During the Hackney Wick period Meldola published many important researches, dealing especially with derivatives of naphthalene and with the azo compounds. This work, of which little notice was taken in England, bore extensive fruit in Germany and assisted the development of the dyestuff industry in that country. Thus, in 1883 he announced the discovery of the preferential reduction of the nitro group in paranitro-azo compounds by treatment with sodium sulphide, thus producing amido-azo compounds which could be rediazotised and coupled with another component. Though

not introduced technically at the time, this reaction has since proved a very fruitful method for preparing cotton dyestuffs of the disazo and trisazo class, as, for example, Columbia Black 2F, Azo Alizarine Black, etc. An alternative method of procedure discovered by Meldola simultaneously with Nietzski, though not published until later, utilises the acetyl-paradiamines for the same purpose.

Meldola's technical researches were in great measure of a pioneer character; they opened up new ground, but were not always capable of bearing immediate fruit. There can be no doubt that had other conditions prevailed in this country, had there been more enterprise and a greater belief in the value of science to industry, these researches would have exerted a profound effect upon the development of the British colour industry. As it was, they fell in great measure upon barren soil.

Scientific Researches.—The small measure of encouragement which Meldola re-

ceived in his technical investigations, and the difficulties under which he worked through want of adequate facilities and assistance, led him almost imperceptibly and unavoidably to devote increasing time to the more purely scientific aspects of the investigations in which he was engaged, a side which always had for him a great attraction. We thus see him publishing, in the last three years of his technical career, extensive memoirs on the azo compounds and on the laws of substitution in the naphthalene series, subjects which continued to claim much of his attention throughout life. Through the whole of his scientific researches there runs, however, a thread connecting them with the more practical aspects of the dyestuff manufacturing industry, for which he always retained a close interest.

In 1885, sadly disappointed and disillusioned by the small appreciation accorded to his efforts by English manufacturers, he retired from active technical work and accepted the position of Professor

of Chemistry at the Finsbury Technical College, a post which he held with great distinction for thirty years. During this period he carried out, with the help of various assistants and students, a large number of researches, which were mostly published in the *Transactions* of the Chemical Society. To give any adequate account of these researches in the space here available is of course impossible, but it may be permissible to indicate very shortly some of the main themes which run through his investigations, and the connecting links which led the investigator from one subject to another.

1. *Laws of Substitution in the Naphthalene Series.*—The researches on this subject, commenced in 1878, were continued for over twenty years and are embodied in eleven memoirs. They assisted materially in clearing up the complicated isomerism of naphthalene compounds and in elucidating the laws which govern substitution.

2. *Researches on the Azo Compounds.*—This work, commenced in 1882, was continued

throughout a large part of the author's life. A considerable number of these researches, comprised in some seven memoirs, were devoted to an attempt to decide the question whether the ortho-azo compounds derived from beta-naphthylamine and beta-naphthol possessed the constitution of true azo compounds or of quinone hydrazides. Meldola thought to solve this point by studying the reduction products of the acetyl or benzoyl derivatives of the azo-beta-naphthol compounds; but, although much interesting experimental data was obtained, the main object failed, through the unexpected circumstance that the acetyl or benzoyl group is able to wander from an oxygen to a nitrogen attachment during the process of reduction. Other evidence was, however, adduced which, in the investigator's opinion, supported the azo structure of these compounds.

3. *Constitution of Diazoamido Compounds.*— Ten papers, published between 1886 and 1895, deal with a remarkable case of abnormal isomerism. Meldola's attention was

first directed in 1886 to the curious fact, first observed by Griess, that identical and not isomeric diazoamido compounds are obtained either by the action of an amine X upon the diazo compound of an amine Y, or by the action of the amine Y upon the diazo compound of the amine X. For example, the anilide of paradiazotoluene is identical with the paratoluidide of diazobenzene. Obviously, in one case or the other a shifting of the hydrogen atom along the nitrogen chain must have taken place. To ascertain in which direction this occurred, Meldola prepared the methyl and ethyl derivatives of the diazoamido compounds (*a*) by combining diazotised paranitraniline with alkylmetanitraniline, (*b*) by combining diazotised metanitraniline with alkylparanitraniline, (*c*) by alkylation of the diazoamido compound obtained by combining either nitraniline with the diazo compound of the other. The remarkable fact was thus disclosed that in this and a number of similar cases, there exist *three* isomeric alkyl diazo-

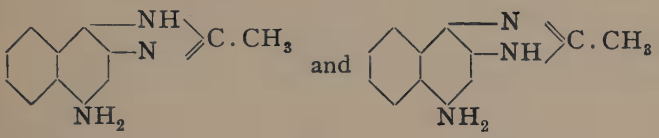
amido compounds, of which (*a*) and (*b*) are resolved by cold concentrated hydrochloric acid into their generators, while (*c*) gives a mixture of both diazo compounds and both amines. Since Meldola further found that the third isomer could also be formed by heating together molecular quantities of the first two, he was at first inclined to believe that the third isomer, and the unalkylated diazoamido compound from which it was derived, had double the usual formula, namely :

$$\begin{array}{c} X.N{-}N.NHY \\ \quad | \quad | \\ XNH.N{-}N.Y. \end{array}$$

This, however, was disproved by the molecular weight estimation, and the investigator was brought finally to the conclusion that the abnormal isomer must be regarded as a molecular compound of the first two, probably held together by the residual valencies of the four nitrogen atoms.

4. *Studies upon Amidoamidines.*—Meldola's investigations upon the substitution products of naphthalene led him incidentally to an

investigation of the anhydro bases of the naphthalene series. Two isomeric amido-ethenyl-*o*-naphthylene-diamines :

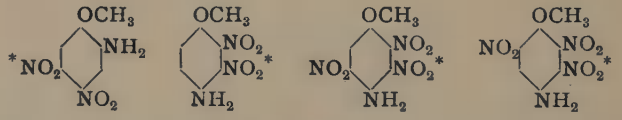


are obtained upon reduction of dinitro-acetyl-α-naphthylamine, the first if tin and hydrochloric acid are used, the second if the reducing agent is iron. The first base also suffers transformation into the second upon treatment with iron and hydrochloric acid. This isomerism does not extend to the simple ethenyl-*o*-naphthylene-diamine. The above structures were demonstrated by ethylation of the two bases and comparison of the products with those obtained from the alpha or beta ethylnaphthylamines by synthetic processes.

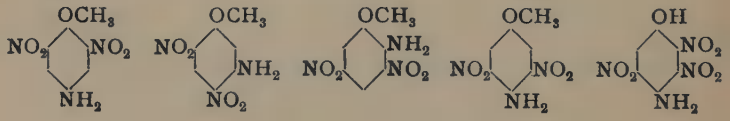
5. *Studies on Derivatives of Phenol.*—Two memoirs published in 1896 and 1898 describe a variety of new halogen and nitro-halogen derivatives of phenol and of guaiacol.

6. *On Mobile Nitro Groups.*—The investi-

gation of this interesting phenomenon, the direct outcome of Meldola's work on the diazo compounds, is embodied in some sixteen memoirs published between 1900 and 1914. It was first observed in the case of the dinitro-*o*-anisidine that elimination of a nitro group and its replacement by hydroxyl occurs during diazotisation if this is effected in absence of mineral acids. Further study showed that the following dinitro and trinitro compounds lose the starred nitro group during diazotisation :



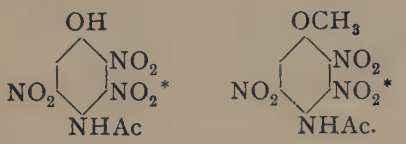
On the other hand, the following compounds are diazotised normally :



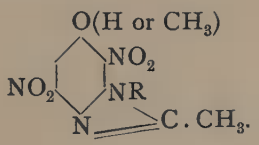
The conclusions drawn from these researches are that the conditions favourable to the mobility of the nitro group are the presence

in the benzene nucleus of an ortho or para diazo group associated with a second nitro group in the ortho position to the first. Even under these conditions the tendency may be counteracted if a diazo oxide can be formed by reaction of the diazo group with a contiguous hydroxy group.

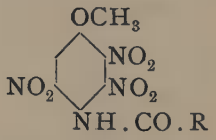
In extending this investigation to the study of the action of amines upon nitro compounds, it was found that the starred nitro group in the following bodies is mobile, its replacement by the amine residue resulting in the formation of an anhydro compound due to the presence of the acetyl group :



These bodies therefore give rise to compounds of the type :

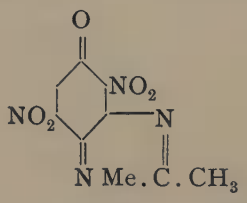


7. *Imidazol Bases.*—In a series of four memoirs, a direct outcome of the previous work, a quantitative study is made of the mechanism of the anhydride formation ("catenation") and of the influence manifested by various radicals in the acid group or in the reacting amine. This was effected by making use of the mobility of the nitro group in compounds of the type :

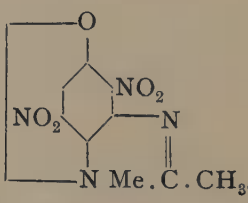


and of their ready interaction with amines.

The imidazolium bases formed by combination of the imidazols with methyl iodide easily lose water, forming compounds of the type :

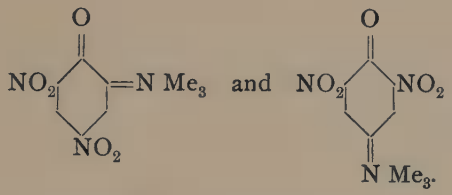


or



8. *Quinone Ammonium Compounds.*—From

the results obtained in the previous investigation, Meldola was led to investigate the simpler ammonium compounds derived from picramic acid and isopicramic acid. When these bodies were fully methylated they were found to give compounds of the type :



These compounds were investigated from the point of view of the quinonoid theory of colour and in the hope of effecting the resolution of asymmetric members of the class into optically active compounds. This latter expectation does not, however, seem to have been realised.

Meldola's early retirement from manufacturing work, though a gain to academic chemistry, must be regarded as a sad loss to the dyestuff industry. Had he remained in the industry under conditions in which his

great capacity as an investigator could have been effectively directed to technical problems, it is safe to assert that he would have exerted a marked effect upon its development. He continued, however, throughout his life to take a great interest in practical problems, and never lost an opportunity of raising his voice against the neglect of chemical science in its applications to technology. In an address to the Society of Arts in 1886 he sounded the first note of warning on this subject ("The Scientific Development of the Coal Tar Colour Industry"), summing up the matter at the close in the following pregnant sentence :—"In our national characteristic of being 'practical' we are apt to become short-sighted in our manufacturing policy and to recognise only actualities, to the exclusion of the potentiality conferred upon a nation by a broader scientific culture."

This theme is elaborated again and again in his later writings, in which are to be found the most urgent warnings against the state of scientific backwardness and unpre-

paredness from which we have suffered so severely in the present war. Thus, in 1910, in an address to the Society of Dyers and Colourists, entitled "Tinctorial Chemistry Ancient and Modern," he writes as follows: —"The question of the cause of the decline of the British (dyestuff) industry resolves itself in reality into the question of the cause of the Continental activity. The answer to this last question has been staring us broadly in the face for over thirty years. It is amazing that there should have ever been any doubt or any cause suggested than the true cause, which is RESEARCH, writ large! The foreign manufacturers knew what it meant and realised its importance, and they tapped the universities and technical high schools and they added research departments and research chemists to their factories, while our manufacturers were taking no steps at all, or were calmly hugging themselves into a state of false security, based on the belief that the old order under which they had been prosperous

was imperishable. It is true that, when the effects of the new discoveries began to make themselves felt, one or two factories did add a chemist to the staff, but the number and the means of work were totally inadequate. I happened to be one of them, and so I speak with some practical knowledge of the conditions. We were but a handful of light skirmishers against an army of trained legionaries. What could three or four—say half a dozen at a liberal estimate—research chemists, working under every disadvantage, do against scores, increasing to hundreds, of highly trained university chemists, equipped with all the facilities for research, encouraged and paid to devote their whole time to research, and backed up by technological skill of the highest order? The cause of the decline of our supremacy in this colour industry is no mystery—it is transparently and painfully obvious."

All his warnings, however, fell upon deaf ears, and in his presidential address to the

Institute of Chemistry in March 1915, which was largely devoted to the question of dyestuff supplies, we find him saying :— "I may be pardoned on the present occasion if I venture to recall a warning which I sounded nearly thirty years ago. As far back as 1886 I foresaw that the coal-tar colour industry as conducted by us was doomed to decadence in this country. Since 1886, on every suitable occasion I have been endeavouring to instil into the public mind the lesson that the development of this industry abroad has been due to the recognition and utilisation by manufacturers of the results of chemical research. To me, therefore, the crisis threatening our textile industries is no matter for surprise — it appears simply as a relationship of effect to cause. It is generally supposed that the prophet who, justified by events, is enabled to say 'I told you so' is privileged to regard himself with the greatest complacency. In the present case the only feeling I am able to express is one of humiliation."

Meldola, however, was not only the prophet of the decadence of the English colour industry; he was, more than anyone else, the historian of its rise and early development. In a number of his writings, but especially in his presidential address to the Society of Dyers and Colourists in 1908, entitled "The Founding of the Colour Industry," and in his obituary notice of Sir William Perkin, he has given us the most interesting accounts of the early days of this industry and of the history of the first discoveries.

Space will not permit me to refer to other branches of chemistry, such as the chemistry of light and photography, in which Meldola's extraordinarily active and versatile mind found vent. As an author he is also well known.

In regard to personal qualities, I will only say that those who knew him well will deeply mourn his loss as a true and staunch friend whose upright character and sym-

pathetic disposition endeared him to all with whom he came in contact. He was an incisive speaker and an untiring worker. His clear mode of thought and expression, combined with a certain sense of humour and of human insight, never failed to render his writings interesting. In the course of his busy life he took a leading part in many public movements, especially those dealing with the advancement of science, the encouragement of chemical research, and the improvement of education. He was a keen patriot, and at the time of his death was serving on many committees connected with the public service.

II. By Sir T. EDWARD THORPE, C.B., F.R.S.

My acquaintance with the late Professor Raphael Meldola extended over some forty years. How it began is not very material, but it probably had its origin in one of the

meetings of the British Association for the Advancement of Science, occasions from which so many friendships among men of science take their rise. We found we had friends in common in the northern manufacturing town in which I then resided, and this small circumstance created a link of sympathy which ultimately extended and strengthened into a friendship that continued, without intermission, so long as he lived. There were, however, other matters which served to consolidate our mutual interests. We had each taken part in solar eclipse work, and both at the time were ardent photographers. At the period referred to, Meldola, who had been a student at the Royal College of Chemistry in Oxford Street, had rejoined the late Sir Edward Frankland as an assistant in the Normal School of Science at South Kensington, and was engaged in spectroscopic work under Sir Norman Lockyer. This had led to his being sent out to the Nicobar Islands to observe the solar eclipse of 1875—a com-

mission which established his position as a skilful and trustworthy experimentalist.

In the early 'seventies photography had taken a new departure owing to the introduction and rapid extension of dry-plate work, and many of its problems were of considerable scientific interest. Meldola's acquaintance with the scientific principles of the art led him to compile a treatise on "The Chemistry of Photography," which had a considerable measure of success in its day.

For a few months previous to his renewed association with purely scientific work, Meldola had acted as chemist to the colour works established at Brentford by the late Greville Williams in conjunction with Thomas & Dower ; but, although he acquired some knowledge of manufacturing processes as applied to the production of colouring matters, which he was able subsequently to turn to account, his experience was not otherwise very profitable either to himself or his employers. For a time the brilliant discoveries of his successor, Otto

Witt, gave the firm a fresh lease of life ; but even before Witt's departure it got into difficulties, and shortly afterwards ceased to exist.

As South Kensington appeared to offer no suitable opening, Meldola once more turned his attention to colour chemistry, and joined the firm of Brooke, Simpson & Spiller, the successors of one of the earliest and most successful of English colour firms—Simpson, Maule & Nicholson—which had been established mainly by the energy and ability of Edward Chambers Nicholson, one of the most capable of Hofmann's English pupils. Here Meldola discovered the well-known colouring matter with which his name is associated—Meldola's Blue—the most typical member of the oxazine group and the first of the series to be isolated. An account of its preparation appears in the *Journal* of the Chemical Society for 1881. Meldola remained at the Atlas Works until 1885, when he was appointed Professor of Chemistry at the Finsbury Technical College—a congenial

position which he held up to the time of his death.

Of his merits as a teacher and as a chemical investigator others who were actually associated with him in both capacities will, no doubt, be able to offer ample testimony. Nor would I presume to express an opinion concerning the value of his biological work. Competent authorities who enjoyed his friendship for many years will testify to his activities and his services in that connection. But throughout our long acquaintance, curiously enough, it was that side of his work which mainly attracted me, for it was on that side he seemed most inclined to dwell in conversation. It may be that the open-air life in which he delighted, and the sights and sounds of the country rambles we enjoyed from time to time in common, brought up the topics which apparently were uppermost in his mind on these occasions. But I question whether even the atmosphere of the laboratory would have led his thoughts round to chemical subjects.

This might be due to the circumstance that our work in such matters lay in very different directions. At all events, whenever we met, or however long we might be in each other's company, any attempt "to talk shop" died of inanition.

My more intimate knowledge of Meldola dates from 1885, when I was appointed to South Kensington. I saw much of him after he was elected into the Royal Society in 1886. He was not at that period a very frequent attendant at the meetings of the Chemical Society, partly on account of his engagements and partly because the night air and the heated atmosphere of the rooms affected his health—never very robust. But I believe he was actually less frail than he seemed. His thin, wiry frame was capable of much physical effort, and until somewhat late in life no ordinary amount of walking seemed to over-fatigue him. He would scramble over the hills in the neighbourhood of my Devonshire home with all the energy of youth. One such excursion we

made together had in it an element of comedy which may serve as an excuse for its mention. He had noticed on an Ordnance map of the district an indication of the site of a Romano-British camp, and, of course, we must needs set out to find it. We managed to locate its approximate whereabouts, but the exact position could not be discovered until Meldola observed a farm-hand ploughing in a neighbouring field. Any direct inquiry would probably have been met by a stare of Bœotian stupidity, but, by a little skilful examination and a gradual approach to what he wished to learn, Meldola contrived to elicit the fact that an unusual feature in the ground in the vicinity might possibly be what the gentleman was inquiring about. As our informant seemed curious to know the reason for our interest in what after all was only a somewhat bigger ditch than usual, Meldola good-naturedly proceeded to enlighten him. I shall not readily forget the perplexed look which gradually overspread the yokel's features as the tale was unfolded,

or the expression of mingled pity and apprehension with which he slowly regarded the teller. He wholly declined to credit the existence of ancient Britons. He evidently regarded my friend as a harmless lunatic out for a walk with his keeper, and eventually, to Meldola's great amusement, signified as much.

In his sense of fun and love of the whimsical Meldola recalled Charles Lamb. Indeed, I think he and Lamb would have had much in common had they been able to know each other. At all events there were certain mental characteristics of Lamb that Meldola thoroughly appreciated, and he had a store of anecdotes and utterances of Elia—doubtless many of them apocryphal—that he would occasionally retail with much gusto. One of these comes back to me as I write. Somebody—let us say a fellow-clerk in the India House—had twitted Lamb with his infirmity of speech.

"That's my p-p-peculiarity," said Lamb. "Everybody has some p-p-peculiarity."

"Nonsense," said the other. "What is mine?"

"Well," rejoined Lamb, "I sup-p-pose you stir your tea with your right hand?"

"Why, yes, of course."

"Ah, that's *your* p-p-peculiarity. Most p-p-people do it with a s-p-p-poon!"

He could enjoy a sly hit even against himself or his race, provided its fun was pure and free from any taint of malice, and I recall the little nervous twitch and merry twinkle which indicated that the jokelet had got home. He was told the following story, on the authority of a distinguished Scandinavian physicist who shall be nameless.

A certain theological candidate at Upsala came up for examination as to his orthodoxy, prior to ordination. To test him, the Faculty desired to know how he would treat the subject of Jonah and the whale.

After a pause, the candidate tentatively ventured the suggestion that Jonah must have been a very small man.

"We have no authoritative information

concerning the physical characteristics of the prophet," remarked the President in his severest tones. "Your surmise will not suffice."

A ray of hope broke in upon the candidate.

"Well, Jonah, of course, was a Jew, and a Jew, as we know, can make his way anywhere!"

"The Chosen People are certainly a wonderful race and possess an extraordinary faculty of adaptation to circumstances. But however plausible, or indeed well grounded, your assumption may be, I fear the Faculty is unable to regard it as wholly satisfactory."

Then said the candidate in despair, "It must have been a miracle!"

And with that the examination was concluded, the candidate having afforded sufficient evidence of the soundness of his belief.

"Ah," said Meldola, with a merry twinkle and his little nervous laugh, as the narrator

ended, "that will be a fine story by the time I get back to town."

Meldola's knowledge of colour chemistry led me to invite him to contribute to a "Dictionary of Applied Chemistry" which I edited for the Messrs Longmans, and the articles on "Azo-" and "Oxazine Colouring Matters" and on "Primuline"—among the most valuable in the first edition of that work—are from his pen. But compilation of this kind was, I fear, not much to his liking. Although he had an excellent literary faculty, and composition seemed to come easily to him, I think he disliked the drudgery of accumulating bibliographical material and the labour of verifying references, which his fastidious mind and sense of accuracy knew to be necessary. When a second edition of the work was called for, I failed wholly to induce him to undertake the revision of his articles. The subjects, especially that of the azo dyes, had grown so enormously in the interval that, as he frankly confessed, he shrank from the labour.

It must be said also that as he grew older literary effort became somewhat irksome to him, probably from the fact that the various presidential offices he was called upon to fill made increasing demands upon his nervous and intellectual powers. Latterly he suffered much from insomnia, and it was absolutely incumbent upon him to husband his strength.

As one of the early workers on the chemistry of the so-called coal-tar dyes in this country, where the industry actually originated, Meldola's knowledge and experience were of special value as throwing light upon the causes which arrested its development among us. This was a subject upon which he had thought much and written frequently, and he was perfectly clear in his own mind as to what these causes were. Some persons, from not altogether disinterested motives, had attributed our loss of the industry to reasons which well-informed people knew to be wholly inadequate if not altogether erroneous. One

such allegation, persistently spread abroad by some who ought to have known better, was that it was mainly due to the restrictions placed on the commercial use of alcohol by the revenue authorities. There was no difficulty in persuading Meldola to appear before a Departmental Committee appointed to inquire into this question, and the manner in which he dotted the i's and crossed the t's concerning the real reasons why our manufacturers had not succeeded in holding on to the great industry which the late Sir W. H. Perkin may be said to have founded for them, brought conviction to the minds of all unbiassed listeners to the remarkably full and striking evidence he then tendered. To use the common phrase, he completely knocked the bottom out of the misleading contention which had been made to do duty as an excuse for the lethargy and short-sightedness of our manufacturers. We hear very little to-day of the restrictive influence of the excise authorities on chemical industry. Meldola effectually scotched that legend.

Recent events, and a deplorable experience, have brought this question home to us in the most forcible manner. A combination of circumstances placed Meldola in positions in which he was able to give practical effect to views of which the soundness and wisdom are now everywhere recognised. Unfortunately, ill-health overtook him at the very time he needed all the energy and power of work he could command. There is little doubt that his mental and physical strength proved unequal to the strain. He has fallen in the service of his country, fighting an economic battle with the enemy, of which the issue is not yet, as assuredly as if he were doing military duty at the front.

Meldola was a man of many interests, with a singularly alert and receptive mind. Without being what could be called a profound thinker, he could form independent and sound opinions based upon insight and conviction. His tastes and sympathies were too varied to allow him to concentrate himself wholly upon a single subject, or even

a single branch of science. Whatever he touched he touched lightly, but he nevertheless adorned it. As a man of science, he found his happiness in following his inclinations, and his inclinations never kept him in a groove. He was an omnivorous reader, and, being blessed with a retentive and accurate memory, he had a well-stored mind. He had a fund of anecdote, and his dramatic sense made him an excellent story-teller. Like most impressionable and sensitive men, he was very susceptible to the influence of his company. Although easy to engage in talk, it required a congenial atmosphere to evoke his admirable conversational powers. The catholicity of his tastes and interests constituted the secret of his social influence. He had a wide circle of acquaintance comprising all sorts and conditions of men and women—not only of science but of nearly every profession—actors, actresses, men of letters, journalists, artists, lawyers, and politicians. His geniality, wit, ready tact, and courtesy made him

an excellent host, and nowhere did he show to better advantage than in the charming little gatherings of interesting people that he loved to assemble round his hospitable table.

His memory will long be cherished by his many friends as that of an earnest, high-minded man, a warm-hearted friend, wise in counsel and of sound judgment.

NATURALIST

I. By Professor E. B. POULTON, LL.D., D.Sc., F.R.S.

(*Founded by kind permission on an Obituary Notice written for the Royal Society.*)

Raphael Meldola was unique in the breadth and depth of his scientific knowledge. Amid all the ever-increasing specialisation of our age, "he kept alive and fresh

every one of the diverse interests that had appealed throughout his life to his many-sided intellect: by sure scientific insight he spoke with authority on them all."[1] The scientific reviews written by him deal with works in various different departments of the following subjects :—Chemistry, organic, inorganic, and industrial; Astronomy; Photography; Natural History; Anthropology; Evolution; Government in its relations with Science.

The same breadth is illustrated by the scientific committees of the British Association on which he served for many years. The record of a single year will suffice. In 1896 Meldola was Chairman of the Corresponding Societies Committee, and a member of the following five committees :—(1) Application of Photography to the Elucidation of Meteorological Phenomena; (2) Seismological Investigation; (3) Action of Light upon Dyed Colours; (4) The Life-history and Economic Relations of the

[1] *Nature*, xcvi., 1915–16, p. 347.

Coccidæ of Ceylon; (5) Ethnographical Survey of the United Kingdom.

The recognition of Meldola's far-reaching powers implied in the above statements was of course based on his original contributions to learning. Here too the researches of a single year will afford sufficient evidence of the extraordinary range of his intellect. In 1882 he published "Contributions to the Chemical History of the Aromatic Derivatives of Methane";[1] "Mimicry between Butterflies of Protected Genera";[2] and with General Pitt Rivers and W. Cole he issued a "Preliminary Report of the Committee appointed to investigate the Ancient Earthwork in Epping Forest, known as the Loughton Camp."[3]

As a result of his varied knowledge Meldola was often able to bring one science to bear upon another, and this always gave him great pleasure. I well remember his keen

[1] *Trans. Chem. Soc.*, vol. xli. p. 187.
[2] *Ann. Mag. Nat. Hist.*, Dec., p. 417.
[3] *Rep. Brit. Assoc.*, p. 274.

interest, when he was staying with me in 1891, and we found that the cocoons of the Small Egger and other moths were chiefly made up of oxalate of lime ;[1] and his delight in telling how he detected the scent of the essence of jargonelle pear (amyl acetate) emitted by the expanded fans on the fore legs of a male moth.[2]

An interesting example of the persistence of his intellectual hold is seen in his letters to *Nature* on the crystalline forms of ice as shown in frost patterns, etc., a subject that lay outside his regular researches. His first letter on "Ice Filaments" in 1880 (xxi. p. 302) was followed by others in 1892, 1902, and 1912, as, at intervals of ten or twelve years, some fresh record or observation made by the way set his mind working in the old track.

[1] *Proc. Ent. Soc. Lond.*, 1891, pp. xv, xvi.

[2] *Herminia tarsipennalis. Essex Naturalist*, ii., 1888, p. 113 ; also *Nature*, xxxviii., 1888, p. 486. Several years earlier Meldola had published the suggestion that the fans of this very species were probably scent-organs (edit. note to Weismann's *Studies in the Theory of Descent*, 1882, p. 103).

I have never met anyone—only intimate friends can have known it fully—who was more alive to the human associations in which, happily for us, the science of our day is so abundantly rich. In other ages other intellectual activities held sway ; in our own age science, being the spirit of it, is richest in human associations. Those who have stood in the way in the early years when an awakening interest may be helped or thwarted, can never have realised their responsibility. But how great it is !—the responsibility of encouraging or of hindering a young man on his way to join the great and varied army that is pushing on into the unknown, and is doing the real inspiring work of the world. Think of all that he may lose not only of work but of comradeship, of how, in being forced, against his inclination, to study the "humanities," he may miss his best chance of knowing man himself.

Meldola's former pupils whose first original work was done with him and who have

now risen to eminence will tell of all that he was to them. In the intimacy of our long friendship I was permitted to see the other side and to know what they were to him—how he valued his association with them and all who helped him in his work, how anxious that justice should be done them when they had left him to make their own way in the world. And the associations of his own youth were equally dear to him. He often spoke of those who had encouraged his early interest in science, especially of John Keast Lord, and I found written in his copy of "At Home in the Wilderness" (London, 1867):

"This book was written by my first natural history friend—my ideal of manliness—my first subject of hero-worship as a youth. His death in 1872 was the first real grief I ever experienced. I was with him at Brighton almost to the end.—RAPHAEL MELDOLA."

He had also noted, in later years, that his old entomological diary held the records of "first years of collecting at Leyton and else-

where, 1869–1874: five happy years of my life!", and added "The W. J. A. of these notes is my *first* entomological friend, William John Argent of Wanstead." Then followed a little history of Argent, and a note that through him Meldola first came to know the Coles in 1869, a friendship connected with the origin of the Essex Field Club (p. 102 below).

Meldola kept the same love for the human associations of natural history throughout his life. With him collecting was always a social pursuit, and each prize had its own special memories. He would speak with delight of a very rare moth[1] captured by his mother at Deal, of a unique variety[2] of a common moth found by his wife.

The happiness of Meldola's married life was heightened by common interests. His wife was not only the companion who collected with him in summer vacations, but

[1] *Nonagria sparganii* captured in a back garden. *Entomologist's Monthly Magazine* (quoted hereafter as *E.M.M.*), xxi., 1884–85, p. 135; *Entomologist*, vol. xvii., 1884, p. 253.

[2] *Melanippe fluctuata*, var., taken Aug. 12, 1912, at Dunbar.

the friend who entered into every side of his life, who sympathised with him in all his work and delighted to know that her sympathy was an encouragement, and that she could give him practical help as well—for all the typewriting of his work was done by her.

Meldola was ever a field naturalist. Although more and more deeply immersed in his chemical research and teaching, the summer holidays which brought him renewed vigour were always devoted to collecting insects. For many years he had regularly gone to Scotland, in 1910 and 1912 to Haddingtonshire, where Miss Balfour is forming a collection of the local species. The interest in common with another naturalist in the field, and later on in the study and comparison of specimens, was a great pleasure to him.

His collection of British butterflies and moths, which stood for so much, he bequeathed to Oxford University, desiring that it should be sent by road at his expense, "in

van with *great thicknesses* of mattress, straw, etc., for cabinets to stand upon." But while thus showing the greatest concern for its safety, he expressed his "wish that if the Hope Professor for the time being of that Museum desires at any time to distribute all or any part thereof amongst other British collections he shall be at liberty to do so."

As I look back over the thirty-two years of our warm friendship, many memories are recalled. My first meeting with Meldola was the direct result of scientific interests in common. It was on November 7, 1883, at the Entomological Society of London, of which he had been a fellow since 1872. I, on the other hand, not yet elected, was attending a meeting for the first time, and reading my first paper, which owed its existence, as stated in the opening paragraph, to Weismann's essay on "The Origin of the Markings of Caterpillars," "together with Mr Meldola's important additions to the English translation."

I well remember one observation we made

together a few years later. Meldola was staying with us in the summer of 1887, a time when I was experimenting on insect-eating animals, especially lizards, and endeavouring to find out the meaning of the colours and markings of insects. We had put in the cage a living specimen of the Small Heath Butterfly, which at once settled on the floor with closed wings, and the "eye-spot" at the tip of the fore wing distinctly visible. This is the usual attitude of the butterfly and its allies, on first coming to rest. After a few seconds the fore wings are lowered and the "eye-spot" concealed beneath the hind. Before this had happened we were extremely interested to see a lizard walk up to the butterfly and try to bite the exposed eye-spot. There was no doubt about the intention. The attempt was deliberate, and it impressed both of us deeply. Later on this observation,[1] confirmed and

[1] Recorded in *Colours of Animals*, London, 1890, pp. 206, 207; *Trans. Ent. Soc. Lond.*, 1902, p. 440. See also *Essays on Evolution*, Oxford, 1908, pp. 210, 281–2, 325–6, and references.

extended, played a large part in the recognition of "directive marks" which divert the attention of enemies from the vital parts. In the "Small Heath" the mark is only revealed when the insect would be likely to be seen coming to rest—a moment of special danger. When this moment is passed the eye-spot is hidden.

Apart from observation and work, I have many abiding memories of walks together. The first, about the year 1886, was along the Portsmouth Road, when we stopped for a night at Godalming, and he took me to see his friend Alfred Russel Wallace, who lived there at that time. This was the beginning of another long friendship and many happy memories. About ten years later we walked round the Isle of Wight; and apart from these little excursions, on which some days were spent—for we went at a leisurely pace, allowing free play to Meldola's keen interest in every side of nature,—I remember many shorter walks, near London and Oxford, and at the meetings

of the British Association. On the excursion through the Canadian Rocky Mountains to the Pacific coast, at the Toronto Meeting in 1897, we stayed together for a week at Victoria, Vancouver Island, and divided a few days between Glacier in the Selkirk Range and Lake Louise, near Laggan, above Banff. We collected insects assiduously, and many a specimen in the Oxford University collections remains as a memento of that glorious time.

In holiday times like these, with no pressure of overwork and untroubled by sleeplessness, Meldola's keen sense of humour had full play, and he would be quick to see the amusing side of things. Of humorous writers he was especially devoted to Dickens and Bret Harte. I remember, one evening, when he was staying with us at Oxford, he read aloud Bret Harte's "Mliss," "Dow's Flat," and "Cicely," and it was very clear that they were old and treasured favourites. I remember too his pleasure in recalling a remark made to him by Darwin concerning

Nature, the Great Incorruptible—"She will tell you a direct lie if she can!"[1] And he told with hearty laughter of Darwin's gardener, who was so disappointed when the experiments behaved properly, contrasting his delight at a failure with his grudging admission of success.

Mr F. W. Streatfeild, who was associated with Professor Meldola at the Finsbury Technical College for thirty-one years, tells me that he was most successful as chairman of the students' "socials," and generally related some good story that convulsed them with laughter. Mr Streatfeild remembers two examples of readiness and humour in his dealings with the students.

"Shortly after the Professor had been elected a Fellow of the Royal Society, his students wished to congratulate him upon his election, and he was asked to come into the laboratory. As he entered he was greeted with a deafening noise of cheering and 'tootings' from broken necks of retorts,

[1] *Essex Field Club Trans.*, iii., 1884, p. 67.

etc. At first he was taken by surprise, but when he saw that it was a greeting of congratulation, he ran up the steps of the demonstration table and made an excellent little speech. He told them that he was much obliged for their good wishes, trusted that they in turn would become Fellows, and said he hoped to have the pleasure of offering *his* congratulations, but was afraid he could not manage *quite* so much noise ! His speech was greeted with much cheering and musical honours."

"Arriving at the College one morning, I found a big pool of water on the laboratory floor, and two students, who were responsible for the flood, engaged in a lively discussion as to whose duty it was to clear up the mess. Just then the Professor arrived, and after listening to their views for a short time, he told the laboratory attendant to bring the mop. Seizing this, the Professor himself mopped up the water in a most professional manner. Returning the mop to the attendant, he turned towards the students

and said: 'There, gentlemen, you see it is not *really* a *difficult* thing to do.'"

In 1910, when Meldola delivered the Herbert Spencer Lecture at Oxford, the Hon. D.Sc. was conferred on him—the result of a memorial signed by all the scientific men in the University who were acquainted with his work. This, his first academic recognition—an honour too long deferred,—gave him very great pleasure; and we both felt united by a new bond in that we were sons of the same Alma Mater. Every letter he wrote to me after receiving the degree carried fraternal greeting.

I now propose to give a brief account of Meldola's biological career. His strong bent towards natural history appears in his earliest publications, of which the first, a note on "Fascination exercised by a Frog," appeared in 1869,[1] soon followed by an observation[2] on the British moths which were to provide him with one great interest and his chief recreation throughout life. It

[1] *Entomologist*, vol. iv., 1868–9, p. 232. [2] *Ibid.*, p. 303.

was entitled "Noctuas on Stinging Nettles," and dealt with the attraction of honey-dew for moths. Then followed, in 1870 71, a series of ten articles on "Our Caterpillar Foes," written for *Land and Water* on the suggestion of Frank Buckland and J. K. Lord. "Mimicry in the Insect World," his first paper on the subject he was to advance so greatly in later years, also appeared in *Land and Water* for May 6, 1871. In the same year he brought forward evidence[1] in support of the suggestion that butterflies whose females are handsomer than the males are those in which the former sex takes the active part in courtship. Under the date July 6, 1872, he wrote[2] in defence of the A. R. Wallace laws of the association of concealing colours with edibility, and brilliant colours with unpalatability in larvæ.

Thus in three or four years it had become

[1] *Nature*, iii. p. 508: quoted by Darwin in *Descent of Man*, 1874, p. 319.

[2] *E.M.M.*, ix., 1872–3, p. 68.

clear that his chief biological interest lay in the study of evolution in relation to insects. The limits of space prevent me from speaking of all his publications on this subject, but there are many which cannot be omitted in any adequate account of the man and his work.

In a paper published by the Zoological Society in 1873 (*Proceedings*, p. 153), "On a certain Class of Cases of Variable Protective Colouring in Insects," he argued for "*a power of adaptability* on the part of each individual" —a power which he contended was conferred by natural selection. This paper was the foundation from which sprang a large amount of work, which he followed with keen interest and sympathy. "Entomological Notes bearing on Evolution"[1] appeared in 1878, founded on Fritz Müller's letters from Brazil. He here dwelt on the bionomic importance of habits, and their evolution through natural selection—a subject which always retained his interest. His

[1] *Ann. Mag. Nat. Hist.*, 1878, 5 ser., i., p. 155.

first Presidential Address to the Entomological Society in 1896 [1]—"The Speculative Method in Entomology"—was a defence of the "scientific use of the imagination" in this science.

Meldola also took an active part in discussion, in the columns of *Nature*, on subjects connected with organic evolution. In 1888 he wrote on "Lamarckism *versus* Darwinism" (xxxviii. p. 388); in 1891 on "Co-adaptation" (xliii. p. 557; xliv. p. 7); in 1896 on "The Utility of Specific Characters" (liv. p. 594; lv. p. 29)—a subject to which he devoted his second Presidential Address to the Entomological Society, "The Utility of Specific Characters and Physiological Correlation." [2]

One of the dominant influences on Meldola's life was his eleven years' friendship with Charles Darwin, for whom he always felt the strongest affection and veneration. Meldola was secretary of the Entomological

[1] *Proc. Ent. Soc. Lond.*, 1895, p. xlviii.
[2] *Ibid.*, 1896, p. lxii.

Society of London from 1876 to 1880, and Darwin was accustomed to refer to him the observations on insects made by Fritz Müller in Brazil. A warm friendship sprang up in this way between Meldola and the great German naturalist, many of whose observations were published in this country. Meldola always thought that Fritz Müller ought to have been an early recipient of the Darwin Medal of the Royal Society, and it is probable that many naturalists felt the same when it was too late. Among Meldola's greatest friends were Wallace, Bates, and Trimen, his seniors, as was Fritz Müller, in the important department of evolution that he made his own.

Darwin's correspondence[1] with Meldola is chiefly concerned with mimicry and allied subjects, and with the English translation of Weismann's "Studies in the Theory of Descent," published in 1882. Darwin had

[1] Published in *Charles Darwin and the Theory of Natural Selection*, Poulton, London, 1896, chap. xxv. pp. 193–218.

been greatly impressed by the German original, and in 1877 wrote about it to Meldola, offering to lend him the book. Later on he expressed the opinion that it would be "a public benefit to bring out a translation," and in 1878 agreed to write a preface—although "this is a kind of job which I do not feel that I can do at all well and therefore do not like; but I will do my best." Darwin's last letter, written February 2, 1882, only a few weeks before his death on April 19, expressed the generous wish to be allowed to subscribe towards the cost of the work if any loss should be incurred by Meldola himself. No one who studies this volume can fail to recognise the great additional value it has gained from Meldola's editorial notes.

One of Fritz Müller's letters sent to Meldola in 1872 contained the suggestion that mimicry may be caused by sexual selection, the females of mimicking species having been biassed in their choice by the sight of the patterns of other species (the

models) in their locality. Darwin, in the accompanying letter, spoke of this as "a strange speculation, which I should not dare to publish, about the appreciation of certain colours being developed in those species which frequently behold other forms similarly ornamented. I do not feel at all sure that this view is as incredible as it may at first appear. Similar ideas have passed through my mind when considering the dull colours of all the organisms which inhabit dull-coloured regions, such as Patagonia and the Galapagos Islands." This "strange speculation," which encounters the fatal objection that mimicry is far more characteristic of the female than of the male, occurred to Fritz Müller when he was pondering over possible alternatives to H. W. Bates's well-known hypothesis. When many years later he seized upon an interpretation which satisfied him, it was sent on to Darwin, and by him transmitted to Meldola, so that the English statement of Müllerian Mimicry appeared only a few months after the

German.[1] But Meldola did far more than bring out the translation: he defended the hypothesis in controversy and brought new and important classes of facts to support it. Fritz Müller, in the new hypothesis, suggested that the mimetic patterns of common species were indicative, like the patterns of their models, of some special form of protection, such as distastefulness. Such mimics had, in fact, adopted the same warning colours as their models, but they still remained warning colours. He further suggested that such a resemblance was advantageous to a model as well as to its mimic, because young and inexperienced enemies would learn the meaning of one pattern more easily and with less loss of insect life than two patterns. Meldola was the first to point out that Müller's hypothesis was supported by the

[1] *Proc. Ent. Soc. Lond.*, 1879, p. xx, translated from *Kosmos*, May, 1879, p. 100. Fritz Müller, however, had published in the previous year a brief account of his hypothesis in *Zool. Anzeiger* (Carus), i. (1878), pp. 54, 55. It is probable that he had not sent a copy of this preliminary statement to Darwin, for Meldola told me that he had never heard of it. It is now published, translated by E. A. Elliott, in *Proc. Ent. Soc. Lond.*, 1915, pp. xxii, xxiii.

strong resemblances that ran through the great groups of distasteful butterflies which supply the vast majority of the models.

"The prevalence of one type of marking and colouring throughout immense numbers of species in protected groups, such as the tawny species of Danais, the barred Heliconias, the blue-black Euplœas, and the fulvous Acræas, is perfectly intelligible in the light of the new hypothesis." [1]

Meldola's suggestion, given in his own words in the above paragraph, opened up a new and fruitful field in which much research is still being carried on. Perhaps the most interesting development is the recognition of mimetic resemblances between distantly related groups of stinging insects—wasps, bees, and their allies—a study only just beginning, in which great advance is sure to be made.

Another statement in one of Darwin's letters, dated August 13 [1873], is of interest in relation to recent work on Mutation and

[1] *Ann. Mag. Nat. Hist.*, 1882, 5 ser., x. pp. 417–25.

Mendelism; also as showing the nature of their correspondence and of Meldola's inquiries:—

"It is very difficult or impossible to define what is meant by a larger variation. Such graduate into monstrosities or generally injurious variations. I do not myself believe that these are often or ever taken advantage of under nature. It is a common occurrence that *abrupt* and considerable variations are transmitted in an unaltered state, or not at all transmitted, to the offspring or to some of them. So it is with tailless or hornless animals, and with sudden and great changes of colour in flowers."

The biological work, of which a brief account has been given above, formed the ground on which Meldola was proposed by Charles Darwin for the Fellowship of the Royal Society. He was elected in 1886, after too long an interval, as many thought at the time and all will acknowledge now. His claims would probably have been recognised earlier if they had been strong in

only a single scientific subject instead of being strong in many.

Meldola took a most important part in the foundation of the Essex Field Club, which grew out of a movement initiated in 1879 by his friend William Cole. The inaugural meeting took place on January 10, 1880, when Meldola was elected President, with William Cole as Hon. Secretary, a position he has held ever since. Argent (p. 84 above) was the first Librarian. In his Inaugural Address, February 28, 1880, Meldola set forth the primary object of the Club — "the furthering of science — the annual addition of something, however humble, to the general stock of human knowledge." He pointed to the good that should be done by "mutual intercourse, . . . and, above all, by fostering and educating the scientific faculty in our younger members."

The successful foundation and development of the Essex Field Club led Meldola to think and write on many important sub-

jects which fell within the sphere of operation of this and similar societies. Thus in 1883 he read and reprinted in *Nature* (xxvii. p. 447) a paper before the Club on "The Conservation of Epping Forest from the Naturalists' Standpoint," a subject which retained his keen interest and support to the end of his life. In 1894 and 1895 he took a leading part in explaining the necessary work which had been done in Epping Forest, thus defeating an ignorant agitation against the management. In 1883 he also wrote to *Nature* on "Local Science Societies and the Minor Prehistoric Remains of Britain" (xxix. p. 19), arguing that these societies should keep vigilant watch, and prepare maps and other records. His part in the investigation of Loughton Camp has already been referred to. Another local archæological research in which he took a keen interest was the discovery and replacement of the eastern boundary stones of the Forest of Waltham.[1]

[1] *Essex Naturalist*, ix., 1895–96, p. 1; xv. p. 126.

Again, in 1883, a Committee of the British Association reporting on Local Scientific Societies drew up rules under which recognition might be extended to those local societies which made the best use of their opportunities. The rules were set in operation in 1885 by the new Corresponding Societies Committee, of which Meldola was the first Secretary, then Chairman, and remained a member until 1910.

The occurrence of the considerable earthquake in East Anglia on April 22, 1884, afforded the young society a fine opportunity, of which, under Meldola's guidance, and largely as the result of his own investigations, a splendid advantage was taken.[1] In this, as in other directions, the Essex Field Club has been a model of what a local scientific society should be.

His interest in earth-movements being thus aroused, he became a member of the British

[1] *Nature*, 1884–85, xxxi. p. 289; *Essex Field Club Special Memoirs*, vol. i., 1885, by R. Meldola and William White; *Proc. Geol. Assoc.*, 1887, ix. p. 20.

Association Committee "On the Advisability of recording Earth Tremors"—the precursor of the Seismological Committee.

Meldola was ever on the alert to make the local societies more efficient and to suggest lines of work for them. Thus, when staying with us at Oxford, he happened to meet Professor Bayley Balfour, and, as a result of their conversation, induced him to send a communication to the Corresponding Societies Committee, in which members were shown the importance of studying the life-histories of the common plants growing at their doors.[1]

Meldola's work for the Essex Field Club and kindred societies is but one striking example of a fine public spirit that was manifest throughout his whole career, from 1867, when, soon after leaving school, he delivered free lectures to Jewish working men, thus starting a movement which developed into the first Jewish Working Men's Club. His repeated efforts to place

[1] *Report British Association*, 1888, p. 261.

industry upon a scientific basis have been spoken of by Sir William Tilden. He also took a keen interest in technical education, and the organisation of the Chelmsford centre, of the Countess of Warwick's schools at Bigods, near Dunmow, and the Duchess of Sutherland's at Golspie, was planned with his advice and continual help. It is greatly to be hoped that his addresses, articles, and letters on Science and Industry, and on Scientific and Technical (including Agricultural) Education, may be published in a collected form without delay. They would be of the utmost value in preparing for the period of reconstruction that is before us. We have lost him when he was needed most, but his teachings remain, and it is for us to make use of them.

The outbreak of war found this country in an extraordinary and difficult position. In August 1914 the nation suddenly awoke to realise the dangers into which it had been allowed, nay encouraged, to drift—with important industries, formerly flourishing,

represented chiefly or entirely by crowds of clerks ordering goods from a foreign land. And that foreign land had, in an instant, become the bitterest, most unscrupulous and ruthless foe ever encountered in our long national history. In this crisis Meldola's remarkable knowledge and wide experience of the sciences that form the foundation of the industrial arts was of inestimable value. He saw the need and, suffering as he was from the strain of overwork and far from strong, threw himself, heart and soul, into his country's cause. As early as August 29, 1914, while on his holiday in Scotland, he wrote to a colleague : "I think of preparing a general plan of campaign for recovering British chemical industries lost through German competition."

Soon after his return, on September 22, 1914, Meldola presided at a joint meeting of the Councils of the Institute of Chemistry and the Society of Public Analysts to consider the supply of laboratory requirements. A special committee on laboratory reagents,

and another on glass, porcelain, and filter-paper, were the result. Meldola was a member of the first committee, which prepared a list of reagents, with notes on the necessary standards of purity, and quickly brought about a satisfactory supply. He was Chairman of the second committee, which took steps to ensure good British-made supplies of porcelain and filter-paper. Glass,[1] being required for so many purposes, was a matter of much greater urgency and difficulty ; and to speed up the matter, the Council of the Institute of Chemistry, on October 30, 1914, appointed a Glass Research Committee with Meldola as Chairman. He attended nearly all the numerous meetings, and, except when prevented by ill-health, visited the Institute once and

[1] Meldola wrote to me, October 28, 1915: "A striking example of the result of *applying* science is the development of the German optical and chemical glass industry, all of which at the time of the war was in the hands of our enemies." An excellent summary of the work of the Glass Research Committee of the Institute of Chemistry is given in *The Engineer* of March 24, 1916, p. 249. In drawing up this brief account of Professor Meldola's work at the Institute I have received much kind help from the Registrar and Secretary, Mr R. B. Pilcher.

more often two or three times a week, in order to keep in touch with the progress of the work. The last meeting he attended at the Institute was in connection with the Glass Research Committee, and he called with reference to its work only three days before he died.

In addition to all this work at the Institute, Meldola was one of the first to suggest to the Board of Trade the appointment of the Chemical Products Committee, of which he became a member ; he was Chairman of the Advisory Council of British Dyes, Limited (see pp. 5, 6 above), created by the Government to deal with another vast industrial failure ; and he held a place on the Council of the "Scheme for the Organisation and Development of Scientific and Industrial Research," a belated attempt by the Government to atone for past neglect.

With all this national work on his hands, Meldola was unable to give his help to other causes which were very dear to him. He had consented to be nominated as President

for 1915–16 of the South-Eastern Union of Scientific Societies, but reluctantly withdrew when the pressure on his time became too great. The duties of his professorship could not be relinquished, and the strain of extra work was increased by illness in the spring of last year. On October 28, less than three weeks before his death, he wrote to me :—

"I am still insomnolent and depressed and overwhelmed with work, and every post brings in shoals of letters requiring more and ever more correspondence."

When the call of his country came he was ready, and he worked beyond his strength. England has never had a more loyal or devoted son : he gave up everything for her in the hour of need. And what had the Government of England done for him? Meldola was twice offered a decoration of the Legion of Honour—in 1900 and again in 1907. On both occasions the Foreign Office forbade him to accept the distinction. Can we seriously suppose that it was the wish of Lord Salisbury in the earlier year

or of Sir Edward Grey in the later, thus to treat a friendly nation [1] and the eminent man she desired to honour? No, the cause of the intolerable disgrace must be sought in some wooden system erected by the permanent service—one of many unheeded warnings of disaster and misery that were so soon to follow in the train of official ignorance of science and official contempt for those who devote their lives to science. It is not to be supposed that scientific men more than others value such distinctions; indeed, with so much of absorbing interest to occupy their minds, they are less likely to think too much of them. But, of course, the token of appreciation by foreign scientific colleagues is peculiarly gratifying, and in this instance it was especially so, for, next to his own country, Meldola had always held France to be the dearest land of all.

This is but one change which surely

[1] Meldola wrote to me concerning the 1907 incident: "The Chemical Society of France, on whose recommendation the distinctions were offered, thus received a direct snub from this country."

cannot be delayed, but how many and great are the necessary reforms which rise before us as we think of the life and teaching of the great man we have lost, just when we needed him most! In the steadfast hope, which was also his, that the country will learn the lesson before it is too late, I conclude with words which Meldola had specially noted down so that they might live in his memory :—

"While men strive, and fail, and faint by the way, the work they have tried to do does not fail, but is eternally carried on in ways unknown to them."[1]

II. By Sir ARCHIBALD GEIKIE, O.M.

Seldom have we in this country mourned the loss of a more devoted man of science or a brighter and more generous nature than Raphael Meldola. We were proud of the

[1] From *Knight-Errant*, by Edna Lyall.

remarkable range of his acquirement, for he was not only a chemist of the first rank who made many important researches, but he was likewise a skilled biologist who, if he had given himself to zoological investigation with the same assiduity as he bestowed on chemistry, might have reached a lofty position as a naturalist. But it is not his scientific achievements, splendid as these were, which I would like to dwell on here. Serious as the loss is to science, it is not more so than to his friends is the loss of a bright, kindly, sympathetic personality, beloved by all who had the good fortune to come within the touch of its influence. There could not have been a more genial and helpful friend, nor one whose range of acquaintance with all departments of natural knowledge and whose wealth of sagacious common sense enabled him to give such wise counsel, such valuable suggestions, and such useful criticism. Though his life was mainly spent in chemical investigation and instruction, he had the advantage of having

begun as a biologist, and from first to last he never lost his enthusiastic affection for that living world of plants and insects and birds in which he rejoiced in his earlier years. He kept himself in touch with those living things by constant association with men whose lot was cast in the biological field, and still more by escaping every summer from the work, the worry, and the fumes of the laboratory to some quiet, remote retreat, where he could find himself face to face with that free and fresh Nature which made so strong an appeal to his affections. These annual migrations, in which he was always accompanied by his gentle and devoted wife, served as milestones to mark off the succession of years, and filled his mind with many delightful memories, to recall which was a constant joy to him amid the bustle and gloom of London. How he loved to expatiate on the charms of some of these summer haunts! Few of the annual pilgrims to the far glens of the Scottish Highlands came to them with such eager-

ness to be pleased, or left them with more grateful feelings for the joy and solace which they had ministered to his soul.

It was this duality of interests which formed one source of Meldola's attraction. He was not merely the serious and plodding, the brilliant original man of science, but also the born naturalist who loved every living thing and contemplated Nature with something like poetic rapture.

If anyone wished to consult him on a question of a scientific nature, he was ready at once to enter into the most serious discussion and to give the inquirer the full benefit of his wide knowledge and ample experience. If, again, the question were one dealing with the conflicting personal relationships of life, no one could be wiser and more helpful in the endeavour to remove misunderstandings and sweeten the amenities of intercourse. Or if the need were felt for an interview with some bright and kindly spirit, whose cheerful temperament could lift one up into the fresher air of that outer

Nature which he loved, or into the spacious realm of English literature where he was at home, there could be no comforter more consoling than he.

Those who were privileged with his friendship mourn the loss of a thoroughly loyal friend, a gifted adviser, and a cheerful and stimulating companion. He seemed ever on the watch to do a kindness, and evidently gained as much pleasure from it as he to whom it was done. It was naturally in his own home that these personal characteristics were to be seen in their fullest expansion. It is sad to think that this bright home is now desolate. In the hearts of those who were familiar with it, there lies the deepest feeling of sympathy with the brave partner of his life, over whom he watched with such constant and devoted affection.

III. By Sir F. CARRUTHERS GOULD.

One of the conventions of fictional literature is that a professor is a pedantic creature so absorbed in some special branch of science that he is hardly human. His hair is generally long, and beyond a certain age he always wears a skull-cap. The aim of the novelist is to develop the story so as to show, in the last chapter, that the professor is really a human being.

I had no knowledge of Professor Meldola as an alchemist in his laboratory, a master of the mysteries of chemical research, but from what I saw and knew of him as a lover of Nature in its various forms there was nothing of the pedant or the dehumanised specialist about his personality. I used to meet him very frequently on the excursions of the Essex Field Club in and about the woodlands and glades of Epping Forest, and on these occasions he exhibited an almost boyish freedom from the conventionalities which are supposed to characterise

professorship. He loved Nature in every one of its aspects, and yet, in spite of what always seemed to my unscientific mind his uncanny knowledge of every branch of science, I am quite sure that if we had ever come across the great god Pan in the woods, where I have often thought he still survives, that popular pagan would not have found Raphael Meldola a dull companion.

Whether the subject for the moment happened to be an animal, a bird, an insect, a tree, or a fungus, Meldola was keenly interested and had some information to impart.

In his laboratory he may have concentrated his attention on the abstruse problems which he set himself to solve, but outside he was keenly alive to the broad human problems, and when natural history claimed his attention he might well have claimed that *Nihil naturalem a me alienum puto.*

IV. By WILLIAM COLE.

The beginning of my long friendship with Raphael Meldola was in the summer of 1867, when we met in a glade near Woodford, in Epping Forest. On that afternoon I was aiding my friend, the late W. J. Argent, in the somewhat arduous task of taking photographs in the open by the old wet collodion process, which necessitated the carrying about of a small tent to serve as a "dark-room" (invented by Argent) and one or two cans filled with water for washing the negatives! Argent and Meldola had become acquainted at one of the naturalists' reunions or "evenings" held by the late Edward Newman, editor of the *Zoologist* and custodian of the Entomological Club's collections of insects. We were all enthusiastic collectors, and this fact at once created and cemented a bond of union in our little coterie. I and my brothers soon became most friendly with Meldola, being attracted by his kindly attitude and buoyant spirits

and his love for our favourite amusement. Many meetings happened in the Forest and in the Kentish and Surrey woods, then, as now, the haunts of London entomologists. Meldola's enthusiasm and his rapidly increasing scientific knowledge gave a tone to our companionship, and his remarkable personality increased our admiration for our new friend. Our assemblies at the Entomological Society and in his little study at his father's house in John Street, Bedford Row, were much valued by us all.

He frequently stayed with his Aunts at Park Place, Leyton, where the garden and proximity to the Forest enabled him to increase his acquaintance with the butterflies and moths of the district, a list of which he afterwards published in the *Essex Naturalist*.

From the very first Meldola always took a wider and more philosophical view of entomology than the average collector, and it was at this period that his attention was accidentally directed to the often close resemblance of insects to their surroundings.

It was nearly thirty years afterwards that he spoke of this arresting incident into the "horn" of my phonograph; the wax "record" of his little speech is still intact and is now on the instrument before me. On being played over it runs in this fashion:—

"My first interest in the subject of mimicry and protective resemblance was aroused by an observation I made about the year 1871, when I saw a moth at rest on a fence in the Lea Bridge road—a moth which I afterwards found out to be *Cucullia chamomillæ*. The resemblance of this moth to a splinter of wood struck me as a most extraordinary thing, but it was not until I afterwards read Darwin's "Origin of Species" that the full meaning of the observation dawned upon me. From that time I took special interest in observing the colours and markings and mode of rest of insects with reference to their surroundings; and when the memoirs of Bates, Wallace, and Trimen fell into my hands, the whole subject of

mimicry became clear to me. That was the beginning of the studies which I afterwards carried out in this subject. . . ."

The above observation deeply impressed him, and it was doubtless the impulse of his lifelong interest in the bionomics of insects —an interest which led to the excellent results displayed in his various papers on this fascinating branch of entomology.

During the late 'sixties and onwards, we were in very frequent fellowship in rambles in Essex, Kent, and Surrey. This was whilst we resided in Clapton. In 1878, on our removal to Buckhurst Hill, in the centre of the Epping Forest district, Meldola's visits became quite an "institution," and he sometimes stayed with us for week-ends, so as more readily to explore the woods and surrounding country in the evenings as well as the daytime. In 1879 we spent the Easter vacation in New Forest, Hampshire—a visit memorable for the great snowstorm which, though highly unfavourable for collecting, afforded us small adventures, unpleasant

enough at the time, but often recalled with amusement in after years. In looking back on these "outings," it is pleasant to remember that Meldola's *bonhomie* was always in evidence, and his simplicity and cheerful serenity in the humblest surroundings was one of his most agreeable and companionable characteristics, imparting general contentment to even the most trivial holiday. I cannot call to mind any unpleasantness or suspicion or quarrelling in our "dis-semblies" (Meldola's pet term for the quartette) during a friendship of nearly fifty years—surely a happy record !

V. By WILLIAM WHITE.

My friendship with Raphael Meldola began in 1880, in connection with the foundation of the Essex Field Club, of which he was the first President, I being one of its earliest

members. The Club was founded by Mr William Cole, who devoted his life almost entirely to its organisation as a Natural History Society, the operations of which consisted in carrying on observations in the field, with meetings for promoting scientific investigations. The high character of its proceedings attracted the attention of leading men of science, many of whom assisted at its meetings. The success of its operations was, however, chiefly to be attributed to the constant and energetic control of Raphael Meldola, who was for many years its President, and whose masterly inaugural address, in which the purposes of the Club were expounded, immediately established the standard of excellence which was always maintained. He was rarely, if ever, absent from its meetings, whether "afield" or "at home," and everyone rallied to his standard. His influence was due, not only to his somewhat striking personality, but still more to the precise knowledge which he displayed on multifarious subjects. But his knowledge

was exhibited with such geniality and modesty that he won the confidence of all who listened to him. Wherever he was, his characteristic friendliness was shown to all with whom he came into contact, and, although most discriminating in his judgments, I have never known him behave in a slighting manner towards anybody. At the annual reunions of the British Association, which he frequently attended, he was one of the most active workers. He may be said to have been the creator of the Corresponding Societies section of the British Association, which received appointed delegates from the various natural history and other scientific societies throughout the country. Underlying all his activities there seemed to be a profound regard for the secret truths of nature.

In addition to these characteristics he was intensely practical. By way of illustrating this, I call to mind a remark that he made to me after a meeting of the Entomological Society. We were speaking of the too great

neglect of science, as ordinarily apprehended by business men, and he observed : " There is no better foundation for a business career than a scientific training ; a young man thus equipped is fit for *any* kind of business."

With regard to the wide range of subjects in which he exhibited great proficiency, I have known several enthusiastic students of nature who possessed the faculty of acquiring extensive knowledge of many abstruse technical subjects, but none to the extent attained by my friend Raphael Meldola. Moreover, when giving a demonstration on any debatable topic, he always clarified and embellished whatever matter he dealt with.

This extraordinary faculty was exhibited very remarkably in his work on a subject outside his own special domain of chemistry, namely, his English edition of Weismann's " Studies in the Theory of Descent " (1876), which he translated and published in 1882, in two volumes. This was a great improvement on the original German work, which he revised and extended, adding a lengthy intro-

duction, Charles Darwin contributing the preface. By means of this undertaking, it is also interesting to note, as he told me, Meldola *taught himself German.*

Another illustration of the cosmopolitan breadth of his knowledge may be given. At one meeting of the Essex Field Club, an illustrated lecture was to be contributed by Mr Worthington G. Smith, F.L.S., F.R.H.S., an expert authority on flint implements, especially those which he had collected himself in the Lea Valley district, of which he knew every foot. The preliminary business over, a telegram of apology was received from Mr Smith. Everyone supposed that the meeting would be declared adjourned forthwith ; but, instead, the President arose, expressed his regret at the disappointment, and—leaping into the breach—himself gave an excellent lecture on primeval man and the Stone Age, in relation to the geological and glacial periods — to the astonishment of all who were present.

But Meldola was also famous as an ardent

champion of evolution. He had visited and corresponded with Darwin, and was an intimate friend of A. R. Wallace and H. W. Bates.

At that period, it is interesting now to recall that the majority of those who took the leading part at the meetings of the Entomological Society — including such recognised authorities as Professor J. O. Westwood (Hope Professor of Zoology at Oxford), Messrs H. T. Stainton (of Tineina fame), Philip Henry Gosse (the seaside naturalist, author of "Omphalos," "Evenings at the Microscope," etc.), though rarely present, and Robert M'Lachlan—belonged to the old school of naturalists, who regarded little else than the discrimination of species, from a merely classificatory point of view; and as such they were rabid opponents of the doctrine of evolution, or the descent of species by modification, etc. They were thoroughly expert systematists, but if anyone dared to encroach on their sacred ground by introducing the pestilential heresy of "the

survival of the fittest," the effect was as the flaunting of a red flag in front of a bull. There were, however, three members of the Society, at least, who seemed to take a pleasure in defying the antiquated classifiers, and who lost no opportunity of explaining the abnormal variations peculiar to the individual specimens exhibited by them and others, on the lines of the principles of evolution and natural or sexual selection, and who went so far as to furnish lengthy papers as the result of elaborate researches carried on upon that foundation. These three members—who may be aptly compared with Shadrach, Meshach, and Abednego—were Raphael Meldola, Professor E. B. Poulton (subsequently President of the Society), and myself; and these three "heretics" invariably supported each other in the unholy discussions which took place, in which the authoritative influence and heavy weight of evidence brought into the argument by the recalcitrant Meldola were all-prevailing, being totally irrefutable.

During the months I was engaged with him in collaborating on the "Report of the East Anglian Earthquake in 1884," I had ample opportunity of knowing how methodical, precise, and business-like he was in his habits and in his literary work. No one knew better how to deal with accumulated masses of heterogeneous material, to co-ordinate facts, accepting tentatively whatever might prove of value, refusing whatever was unsupported by sufficient evidence. The element of caution at every step he took was so characteristic a feature with him that those who knew him well may recall the nervous care he exercised when descending a staircase with which he was unacquainted. This slight peculiarity was a significant indication of the prudent watchfulness of the man of science.

ASTRONOMER

I. By Sir ALEXANDER PEDLER, C.I.E., F.R.S.

My friendship with the late Professor Meldola extended over a period of more than forty years. Our acquaintance first began as students, before I went to India in 1873, and it ripened into friendship in the year 1875. At that time Meldola was assistant to Mr Lockyer (now Sir Norman Lockyer), and as Sir Norman could not be spared from his work to observe the total eclipse of the sun on April 6, 1875, in the Nicobar Islands, Meldola was deputed in his place. The expedition, under the auspices of the Royal Society, left Southampton on February 11, 1875, and consisted of two parties, one under Dr Schuster, going to Siam, and the other under Meldola, going to Camorta, in the Nicobar Islands.

The expedition reached Galle, where the Nicobarese party landed. A party from India, also to observe the total eclipse, left

Calcutta on March 11 and picked up the English expedition at Galle on the 18th, arriving at Camorta on the 22nd.

I was one of the expedition from India, and had then the opportunity of renewing my friendship with Meldola, and, as is natural in such an expedition, we became very intimate. The expedition had to live on board the Government steamer *Enterprise* throughout the period, as the islands are noted as being very malarious. They are surrounded by mangrove swamps, and every evening after sundown and at low tide the stench from the decaying vegetation in these swamps was exceedingly bad. Indeed, every silver article we possessed was blackened by the amount of sulphuretted hydrogen in the air. Every morning, before landing on the island for work during the day, every member of the expedition had to submit to "quinine drill" by taking 5 grains of quinine; but even this did not prevent some of us contracting jungle fever, which in my own case came on immediately after the eclipse and periodically

for some years afterwards. Meldola, I think, was lucky and escaped this fever.

The work of preparing for the eclipse was very interesting, and at the same time quite unusual. The Nicobar Islands are the extra-punishment place of the penal settlement in the Andaman Islands, and the prisoners on the island of Camorta, who were told off in gangs of six or eight to help each observer in erecting the observatories, etc., were all of them bad characters and many of them murderers. Of course, every observer was protected by a Sepoy guard during the working period. This was indeed absolutely necessary.

Everything was in very good order on the day of the eclipse, and Meldola was in charge of the quartz telespectroscope for photographing the spectrum of the corona and prominences of the sun. It was hoped that excellent results would be obtained, for the duration of the totality at Camorta was calculated to be no less than 4 minutes 27 seconds, which is an unusually long period

for a total eclipse. Unfortunately, however, though the whole of the forenoon was quite fine and the sky almost cloudless, and the party were successful in observing the external contacts at the beginning and end of the solar eclipse, during the progress of the eclipse clouds gathered in front of the sun, and of the period of totality absolutely nothing was to be seen of the sun, and only the shadow of the moon could be seen, making everything like night for this period.

The description of the eclipse is given in the *Philosophical Transactions* of the Royal Society for 1878. On p. 154 of part i. it is stated: "Considering the complete state of preparation, it is a matter of great regret that the observations were prevented by the state of the weather."

Meldola came back by the *Enterprise* to Calcutta, and as far as I can recollect proceeded to England overland *via* Bombay.

From this period (1875) it was my good fortune to meet Meldola on every occasion

on which I was able to visit England, and to continue and deepen our friendship. For the last ten years, since I retired from the Indian Service, it was again my good fortune to see a good deal of him, as we were together as members of a great many committees. Among other things, I may perhaps place on record that Meldola was one of the best and most able chairmen of committees that I have ever sat under, for he was extremely business-like and direct in all his methods.

I must place on record my very high sense of the great value of the work done by Professor Meldola in so many directions, such as solar physics, biology, and chemistry. His interests and work were indeed very varied, and both wide and deep. As a friend he was one of the most staunch and lovable I have ever had. Science is much poorer by his premature death.

II. By Sir NORMAN LOCKYER, K.C.B., F.R.S.

My old friend Meldola joined me as assistant in the Solar Physics Observatory many years ago, and while with me was employed in work of a very important character, which he carried out with great skill and faithfulness.

He afterwards left me, and ultimately joined the City and Guilds Institute at Finsbury. While there I lost sight of him from the astronomical point of view, but was tremendously impressed by his profound knowledge and interest in biological problems.

As editor of *Nature* I was fortunate enough to secure his assistance in communicating to that journal from time to time articles touching various topics as they arose. This gave me an opportunity of frequent intercourse, and of noting the breadth and workings of his powerful mind, over very wide fields of inquiry.

His death is a national loss, which very many friends besides myself strongly feel.

PERSONALITY

I. By Sir JOSEPH LARMOR, M.P.
(*Cambridge University.*)

I REGRET that my power of judging directly of the subjects of Professor Meldola's activities is so slight. One was very soon attracted by his interesting and unassertive personality. His quiet energy enabled him to maintain a wide field of interests, and at the same time attain to original achievement over a range of scientific activity unusually extensive. His clear, straightforward views and calm advice always commanded the close attention of his colleagues. His keen interest in their work, even when widely different from his own, attracted affinity and personal friendship; and there is perhaps no one whose loss could be more widely felt in the scientific world.

II. By GEOFFREY S. WILLIAMS.

It was at the end of February 1904 that I first came into close touch with Professor Meldola, when he asked me to assist him in the work connected with the proposal to place a memorial to Herbert Spencer in Westminster Abbey, and I am glad to think that from that time onwards I was able to number Meldola among my friends.

It was characteristic of him that he should have originated the movement for the memorial, for he was ever ready with keen appreciation of good work done by others, and never hesitated to give it expression.

This side of his character, as also his marked dislike of anything which was "high-faluting"—to quote an expression I well remember his using on one occasion—was clearly brought out during the weeks in which we worked together. At other times also I have noted the same trait—how he would suggest things which he thought should be done, assist their execu-

tion with wise advice, and yet be content to leave to others the credit of having originated the idea as well as of having carried it out.

Is it surprising that he was regarded by so many with affectionate respect?

III. By W. H. STEAD.

My long association with Professor Meldola started in connection with my ordinary business in a manner which certainly did not foreshadow the development of the many interests through which our friendship was formed.

About forty years ago I was interested in some works in America, where the seed of the cotton plant was partly prepared, and of which the process of manufacture was completed in England. Difficulties arose owing to chemical changes taking place in the material during its transport, and I required

a capable chemist to solve the problem. The curate of the church I attended was dining with me one evening, and as he had not long before left college I asked him if he had any friend who had taken up chemistry as a profession and would be likely to help me. He replied that, before going to the University, he had been for some time a student at the School of Mines, and while there he knew well a fellow-student named Meldola, who was constantly being appealed to by the other students to assist them in the difficulties that arose in their daily work. Raphael Meldola's advice was so good that he gained a great reputation among his co-workers. I asked Meldola to meet me, and he came down to stay with me, and before long he satisfactorily solved my problem; and incidentally we began a lifelong friendship which was only closed by his lamented death last year.

On the occasion of his first visit he suggested the appointment of a permanent chemist at the works in which I was inter-

ested, and recommended a Mr Evershed, who was with me for many years.

Evershed's hobby was the study of astronomy, which he studied to such good purpose that after his work for me was completed he was offered and accepted the appointment of Government Astronomer of Madras, which he still holds. The Observatory is at Kodaikanal, one of the highest peaks of the mountain ridges of Southern India, a most lovely spot in the Pulnai Hills.

Meldola's wide scientific studies made him a most interesting companion, and he made many long visits and spent many holidays with me, of which the memories are delightful to recall.

During one visit Meldola was translating Weismann's "Theory of Descent," and about the same time he also wrote articles on Organic Chemistry for the ninth edition of the "Encyclopædia Britannica." One year we had a most enjoyable trip on the Rhine together, when Meldola was pursuing his

researches into the insect world. So absorbing was this pursuit that we completely got a day out of our reckoning, and being unaware of the fact we were let in for a most amusing incident. We called, as we thought, one Saturday afternoon on Fresenius and found him just going out, looking very smart. He said the laboratory was closed, but invited us to visit it next day. We thought it odd it should be closed on Saturday and open on Sunday, but prepared to go as requested. In the morning of the following day I went to the English church, expecting to see a large congregation, as the Prince of Wales, afterwards King Edward VII., was in Wiesbaden and had notified his intention of attending with his suite. To my astonishment the church was in the hands of whitewashers, and on my making inquiries as to this strange proceeding I discovered the day was Monday, not Sunday. In the engrossing pursuit of moths and butterflies Meldola had lost a day.

We went together to the British Associa-

tion meetings at York in '81 and Southampton in '82. On the latter occasion we went on the Sunday to Lyndhurst to see Meldola's old friend, Alfred Russel Wallace, who was living there at that time. In '83 the meeting was at Southport, which was then my home, and Meldola was my guest.

For the next twenty years I was mostly abroad, so I did not see much of Meldola. After 1906 I again had a house in England and we met frequently. Meldola and his wife often stayed with me, and we made many most pleasant trips together, motoring to various places. On one of his visits, not very long before his death, Professor and Mrs Meldola and Professor Pope (also staying with me) and I made an expedition to Leonard's Lea to see the many fine tropical plants belonging to Sir Edmund Loder, which he kindly showed us. While going through the gardens we met a gentleman who, after looking at Meldola, exclaimed, "After thirty years!" and greeted him with outstretched hand. Meldola replied, "Thirty-five years,

I think." When Meldola was in charge of the British expedition to the Nicobar Islands in 1875, *en route*, in Ceylon, he met Sir Edmund Loder, who, being much interested in the subject of eclipses, joined the party for the rest of the journey. Though the two had not met since, mutual recognition was instantaneous, and they found much of interest to talk about.

Only about a fortnight before Meldola's death, he, his wife, and Professor Pope were staying with me. We drove over to Box Hill, and a photograph was taken of the party, which I have as the last memento of a lifelong friendship.

IV. By ISRAEL ZANGWILL.

Although I met the late Professor Meldola quite frequently, I was never privileged to get into real touch with him, and can therefore contribute no intimate impression.

I was, of course, always struck by his great geniality, which was only exceeded by his modesty; for I cannot recollect his ever saying a single word about his own achievements, or ever making the faintest assertion of the commanding position he occupied in the scientific world.

As President of the Maccabæans he was simply a "jolly good fellow," an ideal combination of humour and dignity. My latest recollection of him is as presiding at a dinner at this Club to the Lord Chief Justice, an amusing anecdote of whose castigation at the hands of a schoolmaster in his boyish days seemed to appeal to Lord Reading rather as an example of things best forgotten; at any rate, he declared he had forgotten it.

V. By EUGENE WILD (Lausanne).
(*Extract from the "Chemiker-Zeitung,"* 1916.)

From the time of his appointment as Professor of Chemistry at the Finsbury Technical College in London, that is, for thirty years, he carried out with uninterrupted industry his successful work in teaching and research.

Obituary notices, correspondents, and friends all represent Meldola as a man of rich endowment, of extreme modesty, charming manners, and rare tact, but of a strong character and with a love of truth which could not be corrupted; ever ready to serve his country, science, colleagues, and pupils. His active spirit did not confine itself to the special line of study which he had made his own; he was interested in physical astronomy, photography, biological research—in fine, the whole range of natural science. In this way he came into touch with many distinguished men both of his own country and of other lands, and we might specially mention that through his work on mimicry and "descent"

he won the appreciation and friendship of Charles Darwin.

Meldola gained many honours and distinctions; in the course of time he was called to the presidential chair of the most distinguished learned and technical bodies of his country. His presidential addresses are little masterpieces permeated with the idea for which he fought with all the warmth he could command—the necessity of intimate co-operation between science and technology. In 1913 he was awarded the Davy Medal.

The leading positions to which he was called meant for Meldola not only honours, but they acted (if such were really needed) as an incentive to give of his best to his country and fellow-citizens. Recent times afforded him a great opportunity to do this, for he belonged to the most active protagonists on behalf of British chemical industry, seeking to render it independent of foreign countries.

VI. By PAUL GOODMAN.

(Secretary of the Spanish and Portuguese Synagogue.)

Professor Raphael S. Meldola, as the grandson of the Haham (Chief Rabbi) of the Spanish and Portuguese Jews' Congregation, London, was, naturally, interested in the welfare of his community.

He became a Yahid (contributing member) of the Synagogue in December 1871, and continued so until the time of his death.

His eminence in the scientific world was much appreciated by his community, and on his election as a Fellow of the Royal Society Sir Joseph Sebag Montifiore, J.P., President, on behalf of the Board of Elders of the Congregation, addressed to him a letter of congratulation, to which Professor Meldola replied :—

6 Brunswick Square, W.C.,
2nd December 1886.

Dear Sir Joseph,

I am deeply sensible of the honour which the Board of Elders have conferred upon me by passing the resolution, the terms of which you

have been so good as to transmit to me. It is needless to say that such a token of recognition of the humble services which I have been enabled to render to the cause of science, coming as it does from that ancient congregation with which our family has been so long connected, is to me a particular source of gratification and encouragement.

I appreciate the kindly sentiments conveyed by the Board all the more highly when I reflect upon the circumstance that the very conditions which have led to the measure of success in the scientific world which has called forth their expression of approbation, have precluded the possibility of my taking an active part in the affairs of the congregation.

The great demands made upon the time and energy of an active worker in science at the present day leave no leisure for the discharge of extraneous duties.

Please convey to the Board my sincere thanks, and believe me to remain,

Yours very faithfully,

RAPHAEL MELDOLA.

As President of the Society of Maccabæans (an association of Jewish professional men

and others for the object of social intercourse and co-operation among its members, with a view to the promotion of the interests of the Jewish race), he was likewise interested in the general welfare of his people.

Professor Meldola was buried in the cemetery of the Spanish and Portuguese Jews' Congregation at Hendon, on the 18th November 1915, and the Rev. S. J. Roco officiated at the funeral.

APPENDICES

I

LETTERS OF SYMPATHY

From amongst the many letters of sympathy which were sent to Mrs Meldola, and which are too intimate for publication, it is permissible to quote the following from the Right Reverend the Dean of Westminster Abbey and Sir J. J. Thomson, O.M., President of the Royal Society.

From the Right Reverend Bishop RYLE, D.D.

The Deanery, Westminster, S.W.,
18*th November* 1915.

Dear Mrs Meldola,

May I venture to send you a very brief note to express my truest sympathy with you in your most sad and sudden bereavement? I had so

recently had a letter from Professor Meldola, that I was at first utterly perplexed and startled at the announcement of your dear husband's passing away.

He took a great interest in the recent service in Westminster Abbey, when the medallions of Wallace and Lister and Hooker were unveiled; and I ventured in my short address to make use of a phrase which he had sent me in a letter.

The country has reason to mourn a very distinguished and eminent man of science. His influence has, I know, been widely appreciated and honoured. I have no right to intrude into the more sacred circle of his friends and intimates; but I can imagine how severely his loss will have been felt among a very large number.

Accept, I beg you, but pray do not think of answering, this respectful tribute to his work and memory. And may God enable you to bear this sore blow with courage and faith and hope!

I am, my dear Mrs Meldola,

Yours in sincere sympathy,

H. E. RYLE, Bp.

FROM SIR J. J. THOMSON, O.M., P.R.S.

HOLMLEIGH,
WEST ROAD, CAMBRIDGE,
20th December 1915.

DEAR MRS MELDOLA,

I know that the Royal Society would wish me, as its President, to convey to you their sympathy and to express their sense of the great loss which science and the Society have sustained by Dr Meldola's death. There are few indeed like him, for he was a master of and leader in many sciences, a most sagacious and courteous counsellor, and a most helpful and valued friend. You have in your bereavement the sympathy of every Fellow of the Society. May I add that personally I had looked forward with much pleasure to the privilege of working with your husband on the Council of the Society, and receiving the invaluable help of his wisdom and experience. Alas! it was not to be.—With much sympathy,

Yours very sincerely,

J. J. THOMSON.

II

OFFICIAL RESOLUTIONS OF SYMPATHY AND APPRECIATION

THE ROYAL SOCIETY, LONDON

BURLINGTON HOUSE, LONDON, W.,
3rd February 1916.

DEAR MRS MELDOLA,

I have been desired by the Council of the Royal Society to express their profound regret at the death of their late colleague Professor Meldola, and to convey to you their sincere sympathy in your bereavement.

They desire me, at the same time, to assure you of their deep sense of the eminent services rendered by Professor Meldola to science and to the Society.

Believe me to be, very truly yours,

J. J. THOMSON,
President, R.S.

COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

At the Offices of the Board of Education,
Whitehall, London, S.W.,
19*th November* 1915.

Dear Madam,

I am writing on behalf of the Committee of the Privy Council on Scientific and Industrial Research to express the very great regret with which we learned of your husband's death, and to convey our most sincere sympathy to yourself. Professor Meldola was a pre-eminent figure in the scientific world, and it is difficult to say how much the teaching of science, the study of scientific problems, and the application of science to industry owes to his work. Some of us in this office have recently come closely into contact with him as a member of the Advisory Council on Research. He devoted himself to this with the greatest good-will; and, short as our association with him proved to be, it left on us a deep impression of his rare abilities, entire disinterestedness, and devotion to his work. His readiness to assist and co-operate cordially with all those who were promoting the advancement of science was conspicuous. His name will

certainly be remembered long wherever learning is honoured, and his death leaves a gap which it will be very difficult to fill.

I am, yours faithfully,

L. A. SELBY-BIGGE.

COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (Advisory Council)

At the Offices of the Board of Education,
Whitehall, London, S.W.,
26th November 1915.

Madam,

I am directed by the Advisory Council on Scientific and Industrial Research respectfully to convey to you the following resolution which was unanimously adopted at their meeting held to-day :—

"That this Council has learnt with keen regret of the death of their honoured colleague, the late Professor Raphael Meldola, and desires to express to his widow their sense of the severe loss which Science and the Nation alike have suffered from

the death of a man so whole-heartedly devoted to their highest interests."

Professor Meldola's wide scientific attainments, his highly trained intelligence, his personal charm, and the modesty of his whole bearing had in the few short months during which the Council has been in existence won for him in a special degree the regard and esteem of his colleagues.

I have the honour to be, Madam,
Your obedient Servant,
H. FRANK HEATH,
Secretary.

CHEMICAL SOCIETY

BURLINGTON HOUSE, LONDON, W.,
20th November 1915.

DEAR MRS MELDOLA,

The Council of the Chemical Society learned with the deepest regret of the death on Tuesday last of your distinguished husband, Professor Raphael Meldola, F.R.S., and desired me to convey to you in their name an expression of their sincere and heartfelt sympathy with you in your grievous loss.

To our own Society, as well as to the whole

domain of chemical science, his loss is an irreparable one, especially at the present time. It has been given to few men to have opportunities of combining so much real practical experience with so profound a knowledge of chemical theory in its manifold phases.

The large number of important Government and other committees of which he was a valued member show how highly his advice and wise counsels were esteemed.

An active member of most of the societies connected with chemistry in this country, he was identified in an especial way with this Society, whose welfare he did his utmost to promote during a continuous service of a quarter of a century on its Council, and his tenure of the Presidential chair was marked by an address of such exceptional interest and foresight regarding the position of chemistry in this country, that the Council distributed several thousands of copies amongst men of influence throughout the land. It was but a short time ago that we were rejoicing that he had been selected as one of the representatives of our science on the Government's new Advisory Council of scientific men, for all felt that his unique experience would there be of the highest value to the nation.

Again assuring you of my own and of my Council's sincerest sympathy.

Believe me, yours very truly,

ALEXANDER SCOTT,
President.

INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND

30 Bloomsbury Square,
London, W.C.,
2nd December 1915.

Dear Mrs Meldola,

At a meeting of the Council of the Institute of Chemistry held last Friday, I was asked to convey to you an expression of the deep regret with which they heard of your great loss, and of their sincere sympathy with you in your bereavement.

I do not need to assure you of the esteem and regard in which Professor Meldola was held by his colleagues, or of the high value which they placed on his services. He was one of the best friends the Institute of Chemistry ever had. He gave his time and energies ungrudgingly to the furtherance of its objects, and under the wise

guidance of his presidency it gained greatly both in usefulness and in prestige.

All the members of the Institute have reason to remember with gratitude your husband's devotion to their interests, and by those also who were more intimately associated with him in the work of the Council his memory will long be cherished as that of a true friend and loyal colleague.

Believe me, sincerely yours,

JAMES J. DOBBIE,
President.

THE ROYAL INSTITUTION OF GREAT BRITAIN

At a General Meeting of the members of the above, held on 6th December 1915, the following resolution was passed :—

Resolved, That the Managers of the Royal Institution desire to record their sense of the loss sustained by the Institution and the world of science by the decease of Professor Raphael Meldola, LL.D., F.R.S., D.Sc., F.R.A.S., F.C.S., F.I.C., Professor of Chemistry in the Finsbury Technical College, Past President of the Chemical

Society, the Society of Chemical Industry, Society of Dyers and Colourists, Institute of Chemistry, and the Entomological Society, Chairman of the Advisory Council of the Board of British Dyers; awarded a Davy Medal by the Royal Society of London. Professor Meldola was one of the most distinguished chemists of the time. His researches in the chemistry of colouring matters, photographic chemistry, his works "Chemical Synthesis of Vital Products," "Coal and what we get from it," and his many original papers on chemical subjects, have opened some rare fields of inquiry, some of which have led to great industrial success.

Professor Meldola was not only distinguished as a chemist, but also as a biologist, and a man of intellectual activity in all departments of knowledge.

He was a member of the Royal Institution for thirty years, and served as a Visitor and a Manager. He delivered two Friday evening discourses: "The Photographic Image," 1890; "Mimetic Insects," 1901. He also delivered a course of lectures in 1905 on "Synthetic Chemistry."

Resolved, That the Managers desire to express, on behalf of the members of the Royal Institution, their most sincere sympathy with Mrs Meldola and the family in their bereavement.

CITY AND GUILDS OF LONDON INSTITUTE

Gresham College,
Basinghall Street, London, E.C.,
14th December 1915.

Dear Madam,

I am desired by the members of the Executive Committee of the City and Guilds of London Institute, including the Committee of the Institute's Technical College, Finsbury, to express to you their sense of the great loss which they in common with many others have sustained by the death of your husband, the late Professor Meldola. His eminent services towards the advancement of chemical knowledge and its application are universally recognised. He could ill be spared, and especially at the present time.

I am to ask you to accept this expression of very sincere sympathy and condolence in your bereavement, tendered on behalf of the members of the Institute.

I am, dear Madam, faithfully yours,
WALTER P. PRIDEAU,
Honorary Secretary.

BRITISH DYES LIMITED

Excerpt from the Minutes of a Meeting of the Board of British Dyes Limited, held on 18th November 1915.

The Directors desire to record their profound regret at the death of Professor Meldola, the Chairman of the Advisory Council of the Company. His acceptance of that position was universally approved, and it was hoped that through it he would give invaluable assistance in promoting a practical proposal on a national scale for the combination of science and industry, a cause which he had advocated with great energy throughout his professional life. The loss of his experience and enthusiasm and wise guidance in regard to the work of the Advisory Council is sincerely regretted by the Directors.

The Chairman was requested to communicate this resolution to Mrs Meldola, and to express their deep sympathy with her.

JAMES FALCONER,
Chairman.

THE SOCIETY OF DYERS AND COLOURISTS

17*th November* 1915.

DEAR MADAM,

On behalf of the Council of the Society of Dyers and Colourists, I write to express our deepest sympathy with you in your bereavement. Our Society has had for a long time the benefit of Professor Meldola's help both as President and in other directions, and his loss will be felt deeply in all scientific circles.

Yours sincerely,

A. SILVERWOOD.

THE SOCIETY OF DYERS AND COLOURISTS

(MANCHESTER SECTION)

7*th December* 1915.

DEAR MADAM,

At the meeting of the Manchester Section of this Society a resolution was unanimously passed expressing the sympathy of the members present with you in your sad bereavement.

We also feel that we have lost one of the staunchest supporters of our Society, whose example and achievements will ever live in the memory of our members.

Yours faithfully,

J. CAMPBELL GRAY.

THE FEDERATION OF THE LIGHT LEATHER TRADES OF THE UNITED KINGDOM

18th November 1915.

DEAR MADAM,

I am instructed by the President and Committee of the above Federation to tender their deep sympathy with you in the loss you have sustained by the death of your husband, Professor Meldola.

Professor Meldola has on several occasions placed his very able services at the disposal of my Committee, and they deeply regret the loss that has been sustained by those industries intimately associated with dyeing, a loss that will be felt most severely.

Professor Meldola by his personality endeared himself to those members of my Committee who had the pleasure of making his acquaintance, and they have been greatly shocked to hear of his demise.

Yours very truly,

M. C. LAMB,
Secretary.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

2 Garden Court, Temple, E.C.,
24th December 1915.

Dear Madam,

At a meeting of the Council of the South-Eastern Union of Scientific Societies on 13th December, I was requested to convey to you the grief that was felt at the recent loss that you had sustained, and respectfully to tender, on behalf of the Council and of the Union, sincere sympathy in your great bereavement.

Several members said at the meeting that they had lost a friend, and that therefore the present expression of sorrow was not merely the official

utterance of the Union, but also one which concerned each personally.

The active interest of Professor Meldola in the affairs of the Union has been eagerly anticipated, for he had kindly offered to assist in the Union's work when circumstances permitted it. The knowledge of this regard for the Union will, I feel certain, be remembered as long as the Union exists.

Believe me, Madam, yours faithfully,

WILLIAM MARTIN,
Hon. General Secretary.

THE WELLCOME BUREAU OF SCIENTIFIC RESEARCH

10 HENRIETTA STREET,
CAVENDISH SQUARE, LONDON, W.,
20th December 1915.

MY DEAR MRS MELDOLA,

On my return I have learned of the death of your husband, and I want to offer you my deepest sympathy in your irreparable loss.

It must be a comfort to you to know how sincerely his passing is mourned, not only by his

many friends, but also by scientific men generally throughout the world. His charming personality will not be forgotten by anyone who knew him.

The British Empire has now more than ever great need of men of Professor Meldola's special qualifications and qualities. For we must break the traditions of lethargy and become regenerated in the field of science. Professor Meldola has for many years earnestly striven to rouse Britain to her needs in technical education and scientific progress, especially in the department of industrial chemistry. May God give you health and strength to bear your great sorrow.

Yours most sincerely,

HENRY S. WELLCOME.

SUTHERLAND TECHNICAL SCHOOL

Excerpt from Minute of Meeting of the Governors of the Sutherland Technical School held on 8th December 1915.

The Governors unanimously resolved to record their feelings of regret on hearing of the death of Professor Meldola. His death will be a great

blow to British science, but to the School it is almost personal, as, from the first inception of the idea of its foundation, he took a deep interest in it, and, by his advice, contributed in no small degree to its success. Latterly the connection had become closer through the gift of badges for the encouragement of swimming and life-saving, so that "The Meldola" is an everyday term in the School conversation.

The Secretary was instructed to transmit to Mrs Meldola a copy of the foregoing resolution.

THE MACCABÆANS

13 Old Square,
Lincoln's Inn, W.C.,
30*th November* 1915.

Dear Mrs Meldola,

On behalf of the "Maccabæans" I beg to express to you the deepest sympathy on the death of Professor Meldola. He was a member from the earliest days of the society, and our President the last five years of his life. I need scarcely tell you how dear he was to all of us who came in contact with him. We shall always remember with gratitude his unremitting labours on our

behalf and his unvarying kindliness of disposition ; and his life will be an inspiration to all who knew him. We grieve at his death at the zenith of his intellectual powers, with heartfelt sorrow.

Yours sincerely,

GEORGE G. SOLOMON,

Hon. Secretary.

THE ESSEX FIELD CLUB

29th November 1915.

Dear Mrs Meldola,

At the General Meeting of the Essex Field Club, held on Saturday last, I was requested to convey to you the very heartfelt regret of the members at the death of Professor Meldola. Professor Meldola had special claims on the regard of the members and officers of the Club, not only as having been the first President, but also because he was always most loyal to the Society, and ever took great interest in its proceedings, endeavouring in many ways to promote its interests and assist in its work. His inaugural address at the first meeting, in February 1880, gave an admirable lead and tone to the work of the Club, and placed its

proceedings on a high level, which enabled the Society to maintain a position second to none amongst similar associations.

The Club is also proud to know that it had the countenance and aid of such a distinguished scientist as our late Vice-President for so many years, and the members and Council beg you to accept expressions of deep sorrow at the loss of so eminent an exponent of the best interests of British science and education. Professor Meldola's beneficent influence and encouragement were of great national value, and we feel that his death at this time, when his guidance in his special subjects was so greatly needed, is a very real loss to the country.

We also most respectfully ask you to accept our warmest sympathy in your great bereavement, which so many of us share, in the form of the loss of a personal and very dear friend.

I am, dear Mrs Meldola,

Yours very truly,

W. COLE,

Hon. Sec.

BRITISH DYES LIMITED

EMPIRE HOUSE,
KINGSWAY, LONDON, W.C.,
10th February 1916.

DEAR MADAM,

At a meeting of the Advisory Council of the above Company held under the chairmanship of Professor W. H. Perkin, who has been appointed to take the place of the late Professor Meldola, I was instructed to convey to you an expression of their sympathy with you in your bereavement. A tribute was paid by the Chairman to the life and work of the late Professor Meldola, which was so largely connected with the industry in which we are engaged, and I may add that the majority of the leading professors of organic chemistry in the United Kingdom were present at the meeting.

I am, Madam, yours faithfully,

S. WHETMORE.

BRUNSWICK SQUARE GARDEN

FOUNDLING HOSPITAL, LONDON, W.C.,
24th January 1916.

DEAR MRS MELDOLA,

At a meeting of the Committee for managing the Brunswick Square Garden held on Saturday last, Mr Eves being in the chair, it was unanimously resolved :—

> "That the Clerk convey to Mrs Meldola the sincere condolences of this Committee with her in the recent great loss she has sustained, and desire to place on record their own deep regret at the loss of a faithful friend and colleague."

Believe me, yours very sincerely,

JOHN B. CHUBB.

III

BIBLIOGRAPHY OF WORKS

ORIGINAL PAPERS, NOTES, REVIEWS, PRESS COMMUNICATIONS, AND BOOKS PUBLISHED BY RAPHAEL MELDOLA

INTRODUCTORY NOTES

IT is certain that, in the event of his death, Professor Meldola wished the following list to be published, although equally certain that, if he had lived, he would, in a few years, have printed it for private circulation only.

Among other notes in an envelope addressed by Professor Meldola to his wife, was one directing attention to a packet containing his "Complete list of publications arranged chronologically." The note continued, "(I intend, if I am spared to reach the age of 70, to have this list printed)."

Outside the packet he had written, "These lists are the story of my lifework. The chronological list is to be published." His own intentions are expressed in the words, "[For private reference only]," written above the title at the head of the Chronological List, and "For printing for private circulation" on the cover.

The other lists are arranged according to subject under the headings—"Chemistry"; "Natural History, etc."; "Miscellaneous Reports, Papers, Addresses, etc."; "Newspaper Articles,

Reviews of Books, Miscellaneous Notes, etc."; and "Literary Works," the latter printed on pp. 224–5 below. Most of these lists had been carried into the year 1912, but none to a later date. The Chronological List, on the other hand, had been completed up to the end of 1914.

The cover of the Chemistry List bears the words, "A poor thing—but mine own!"; also, underlined in red: "The Chronological List is the one found most useful for reference and intended for printing."

The lists are generally written with much care and accuracy, and the relatively few mistakes were probably made when the writer was tired or hurried. Obvious slips have been put right without any indication, but material alterations or additions are enclosed in square brackets. Errors in certain dates of publication have been thus indicated (as in Nos. 32 and 209) in order to explain why the title does not come under its proper year in the list. It is obvious that a list which was written up from time to time over a period of nearly fifty years is unlikely to follow a uniform system of reference. I have followed as far as possible the usual order of:—Title, in Roman type; channel of publication, in italics; date, in Arabic numerals; volume, in Roman numerals; page, in Arabic, except when Roman are printed in the original publication. Neither "vol." nor "p." is ordinarily printed. When, however, the volumes of a publication, such as the British Association Reports, are unnumbered, "p." is printed in order to distinguish clearly between the date and the page. The necessity for this as a principle is well shown in a reference under No. 112, where the *page* 1913 would be in misleading association with the *year* 1912, if the two were not separated by the number of the volume. The titles of all works, not the author's, reviewed or quoted, are, like the channels of publication, printed in italics. In order to emphasise this distinction, italics, except single letters or parts of words, are omitted from the author's titles even when present in the original publication, the wording of which has been strictly followed. Occasional changes in the use of capital letters have, however, been made for the sake of uniformity. The column as well as the page has

been added to those letters, published in the press, which have been traced with difficulty.

I have personally verified every reference that could be found in the Bodleian, Radcliffe, and Union Society's Libraries at Oxford and in the British Museum Library, and desire to record my thanks for much courteous assistance at all these institutions. The small unverified residuum includes only Nos. 54A, 67 (both *Kosmos*), 260, 282, 316 (all three referring to *The Woman's Agricultural Times*, not in any of the above libraries), and 400 (*Yorkshire Observer*).

Much kind help in special parts of the list has been given by Mr W. Cole, Professor G. T. Morgan, F.R.S., Mr F. W. Streatfeild, Mr R. B. Pilcher, and the Editor and staff of *Land and Water*; above all, by a brother-fellow of Jesus College, Mr D. L. Chapman, F.R.S., who has spent much time upon the publications under Chemistry, and has added to the papers printed in the *Transactions of the Chemical Society* the corresponding references to the pages of the *Proceedings*. These contain the record of any discussion which took place at the time of reading.[1] Professor A. G. Green, F.R.S., was unfortunately prevented, by absence abroad, from rendering the assistance he had been anxious to give.

The work has been exacting, but it was a pleasure to help in making the list as accurate as my dear friend would have made it if happily he had lived to edit it himself. He spoke of the Chronological List, in the words quoted above, as "the story of my lifework," and such indeed it is—a story fuller and more complete than even his intimate friends have realised; for many of the publications named below are now for the first time known to be the work of his wide-ranging and untiring intellect.

E. B. POULTON.

[1] When the reference is to *Proceedings* published in the same year as the *Transactions*, it has been deemed sufficient to print "*Proc.*" and page without either year or volume, but otherwise both are given.

CONTRACTIONS

Ann. Mag. Nat. Hist.	*Annals and Magazine of Natural History.*
Berichte	*Berichte der deutschen chemischen Gesellschaft.*
Brit. Assoc. Rep.	*British Association Reports.*
Journ. Chem. Soc.	*Chemical Society Journal.*
Proc. ,, ,,	,, ,, *Proceedings.*
Trans. ,, ,,	,, ,, *Transactions.*
Proc. Ent. Soc.	*Entomological Society of London, Proceedings.*
Trans. Ent. Soc.	,, ,, ,, *Transactions.*
E.M.M.	*Entomologist's Monthly Magazine.*
Journ. Soc. Arts	*Journal of the Society of Arts.*
Phil. Mag.	*Philosophical Magazine.*

Other titles are either in full or contain contractions explained above.

1869.

1. Fascination exercised by a Frog. *Entomologist*, 1868–69, iv. 232.
2. Noctuas on Stinging Nettles. *Ibid.*, 303.
   The recognition of "honey-dew" as a source of attraction.
3. Aplecta occulta in Essex. *Ibid.*, 325.
   The last (and possibly first) record of this species in Epping Forest.

1870–71.

4. Our Caterpillar Foes. *Land and Water.* A series of ten articles [signed "Papilio Machaon"] giving descriptions of mischievous species. Part I., June 11 [1870, ix. 411]; II., July 2 [1870, x. 7]; III., July 30 [*Ibid.*, 82]; IV., Aug. 27 [*Ibid.*, 152]; V., Sept. 17 [*Ibid.*, 204]; VI., Oct. 22 [*Ibid.*, 293]; VII., Nov. 12 [*Ibid.*, 350]; VIII., Dec. 3 [*Ibid.*, 411]; IX., Jan. 7, 1871 [1871, xi. 8]; X., Feb. 4, 1871 [*Ibid.*, 90].
   Written at the instigation of Frank Buckland and J. K. Lord.
5. Popular Errors. *Land and Water*, Oct. 1, 1870 [x. 239. "R. M."].
6. Are Monkeys quadrumanous? *Ibid.*, Feb. 4, 1871 [xi. 91. "R. Meldola"].

7. Hexadactylism. *Ibid.*, March 11, 1871 [xi. 179. "R. Meldola"].

   A case observed in a family at Turnham Green.

8. Power of Instinct in a Moth. *Ibid.*, April 22, 1871 [xi. 287. "R. Meldola"].

   Egg-laying in crevices by Biston hirtaria.

9. Mimicry in the Insect World. *Ibid.*, May 6, 1871 [xi. 321. "R. Meldola"; also May 27, xi. 374].

10. Abundance of the Leopard Moth. *Ibid.*, Aug. 12, 1871 [xii. 95. "M."].

    Moth abundant in London squares, and detached wings at base of tree trunks indicating attack by birds (? sparrows).

11. On the Origin of Blight Life. *Ibid.*, [Jul. 1, 1871, xi. 458, and] Aug. 12, 1871 [xii. 99. "R. Meldola"]. (Polemical.)

12. Chelonia villica feeding on Blackthorn. *Entomologist*, 1870–71, v. 319.

13. The Incessant Circulation of all Nature. *Land and Water*, [Oct. 14, 1871, xii. 259, and] Dec. 2, 1871 [xii. 383. "A Fellow of the Chemical Society"]. (Polemical.)

14. Reviews in *Land and Water* of *Adventures of a Young Naturalist*, by L. Biart [Jan. 28, 1871, xi. 72]; *British Butterflies*, by Edward Newman [May 27, 1871, xi. 379]; *Metallography as a Separate Science, or The Student's Handbook of Metals*, by Blyth, 1871 [June 24, 1871, xi. 452].

15. Sexual Selection. *Nature*, 1870–72, iii. 508.

    See Darwin's *Descent of Man*, 1874, p. 319.

    (About this period an observation that spiders spun webs across panes of glass enclosing gas burners (ordinary street gas lamps) to collect flies, etc., attracted by the light was communicated to *Land and Water* under the title of "A Cute Spider"). ["Cute Spiders," Nov. 5, 1870, x. 331.]

[Professor Meldola's notes also show that the following communications to *Land and Water* were written by him in 1870–71: (1) Entomological notes signed "Midge" in the issues of Aug. 13, 1870; Aug. 20, 1870; Oct. 1, 1870; Mar. 4, 1871. (2) An editorial note before, and a note

signed "Papilio Machaon" after, that by "Midge" of Aug. 13, 1870. (3) Editorial notes following communications on "Eggs of Lackey Moth," May 27, 1871, and "Poisonous Caterpillars," Oct. 14, 1871.

In addition to the above, the following letters are signed "R. Meldola" or "R. M.": "Dr Tyndall's Work on *The Use and Limit of the Imagination in Science*," referring to a review of this work, Jan. 14, 1870; "Spontaneous Generation," Oct. 29, 1870; "Larvæ in Blackcock's Crop," Nov. 5, 1870; "A Supposed Cross between Red Deer and Cow," Nov. 12 and Nov. 26, 1870; "Adipocere," Dec. 31, 1870.]

1872–73.

16. Ants and Aphides. *Nature*, 1872, vi. 279.

17. Artificially-veined Specimen of Pieris rapæ. *Entomologist*, 1872–73, vi. 315.

18. Reviews in *Land and Water* of *Insects at Home*, by the Rev. J. G. Wood, 1872 [Dec. 2, 1871, xii. 386]; *The Specific Action of Drugs* [by Burness and Mavor; Mar. 14, 1874, xvii. 209].

19. The Relationship between Colour and Edibility in Larvæ. *E.M.M.*, 1872-73, ix. 68.

20. Vanessa antiopa at Twickenham and at Hull. *Ibid.*, 109.

21. A case of Mimetic Analogy among British Geometræ. *Ibid*, 163.

(A doubtful case.)

22. On the Amount of Substance-waste undergone by Insects in the Pupal State; with remarks on Papilio Ajax. *Ann. Mag. Nat. Hist.*, 1873, 4 ser., xii. 301.

An attempt to ascertain whether seasonal dimorphism had any connection with length of time and amount of substance-waste in pupal condition. Loss of weight ascertained by direct weighings at intervals.

23. On a certain Class of Cases of Variable Protective Colouring in Insects. *Proc. Zoological Soc.*, 1873, p. 153.

My first attempt to bring variable protective (adaptive) colouring into the domain of Natural Selection.

1874.

24. On the Action of Trichloracetyl Chloride upon Amines. I. Action upon Aniline. (With D. Tommasi.) *Journ. Chem. Soc.*, 1874, new ser. xii. (entire ser. xxvii.), 313.
25. Note on the Action of Trichloracetyl Chloride upon Urea. (With D. Tommasi.) *Ibid.*, 404.
26. Review: *The Laboratory Guide*, by A. H. Church. *Nature*, 1873–74, ix. 420.
27. Joseph Priestley. *Nature*, 1874, x. 239. (Partly mine.)
28. Recent Researches in Photography. *Ibid.*, 281.

    The first recognition in this country of the soundness of Vogel's work on "special sensitizers."
29. Review: *The Amateur's Photographic Guide Book*, by Stillman. *Ibid.*, 284.
30. The Chemistry of Cremation. *Ibid.*, 1874–75, xi. 33.
31. Review: *Practical Chemistry*, by F. Clowes. *Ibid.*, 107.
32. *Elementary Inorganic Chemistry: The Non-metallic Elements.* Murby, 1874 [1873]. [The metals were included in later editions by Professor Meldola.] A fifth edition (undated) published about 1887–89 by J. Castell-Evans.

    This was my first book, and the later edition was sanctioned but not revised by me.

1875.

33. Sphinx convolvuli at Twickenham. *E.M.M.*, 1875–76, xii. 139.
34. Report on the Operations connected with the Observation of the Total Solar Eclipse of April 6, 1875, at Camorta, Nicobar Islands, by Capt. J. Waterhouse. Appendix B, p. 18, Blue Book; Indian Government; Calcutta, 1875.
35. Review: *Watts' Dictionary of Chemistry*, 2nd Suppl., 1875. *Nature*, 1875, xii. 327.
36. Solar Observation in India. *Ibid.*, 400.

    An account of work by Père Lafont, S.J.
37. The new Metal Gallium. *Ibid.*, 481.
38. The Government and the Pollution of Rivers. *Ibid.*, 1875–76, xiii. 81.

1876.

39. Review: *A History and Handbook of Photography*, by Tissandier. *Nature*, 1875–76, xiii. 204.
40. Review: *Dyeing and Calico Printing*, by Crace-Calvert. *Ibid.*, 283.
41. Review: *Kurzes chemisches Handwörterbuch*, etc., by Otto Dammer. *Ibid.*, 483.
42. Review: *Chemical Analysis*, by Dittmar. *Ibid.*, 507.
43. Protective Mimicry. *Ibid.*, 1876, xiv. 330.

1877.

44. Oxygen in the Sun. *Nature*, 1877–78, xvii. 161.
45. Organic Chemistry. *Encycl. Brit.*, 9th edition, vol. v. [1876], p. 544.

45A. Leucania albipuncta at Deal. *Entomologist*, 1877, x. 255. [From separate list.]

1878.

46. Preliminary Notice of a New Yellow Colouring Matter. *Chem. News*, 1878, xxxvii. 56.

    Research abandoned on learning that Otto N. Witt had been working at subject. Product manufactured and introduced by Brooke, Simpson & Spiller as "Citronine"; much used for silk dyeing at one time.

47. On a Cause for the Appearance of Bright Lines in the Solar Spectrum. *Phil. Mag.*, 1878, 5 ser., vi. 50.

    An attempt to develop the principle of "association" in outer region of sun's atmosphere as the result of the cooling down of dissociated gases. Referred to in Sir Wm. Siemens' *Conservation of Solar Energy*, 1883.

48. The Recent Appearance of Colias edusa. *E.M.M.*, 1877–78, xiv. 110.

    (See R. Adkin, *Proc. South London Ent. Soc.*, 1914–15, p. 27.)

49. Entomological Notes bearing on Evolution. *Ann. Mag. Nat. Hist.*, 1878, 5 ser., i. 155.

    Notes based on letters from Fritz Müller, etc.; recognition of the principle of selection of psychological characters (habit) when of use for protective purposes.

50. Studien in der Naphtalinreihe. *Berichte*, 1878, xi. 1904.
51. The Telephone. *The West End*, 1878, i. 2.

A contribution to No. 1 (Jan.) of a new magazine which did not long survive.

1879.

Chemistry.

52. Zur Kenntniss der Di- und Triderivate des Naphtalins. *Berichte*, 1879, xii. 1961.
53. Einwirkung von Nitrosodimethylanilin auf Phenole, welche nicht die Methylgruppe enthalten. *Ibid.*, 2065.

The first synthesis of an Oxazine colouring matter.

Miscellaneous.

54. Leucania extranea at Walmer. *E.M.M.*, 1878–79, xv. 107.

Figured in Barrett's *British Lepidoptera*.

54A. [Ituna and Thyridia; a remarkable case of Mimicry in Butterflies. *Proc. Ent. Soc.*, 1879, p. xx; translated by Meldola from Fritz Müller's paper in *Kosmos*, May, 1879, p. 100. See No. 67.]

55. Butterflies with Dissimilar Sexes. *Nature*, 1878–79, xix. 586.

1880.

Chemistry.

56. On a New Class of Colouring-Matters from the Phenols. *Chem. News*, 1880, xlii. 39. (Preliminary notice.)

Recognition of a new group which afterwards proved to be Oxazines. (See No. 61.)

56A. Diazo-colours with more than two Sulpho-groups. *Ibid.*, 60 (refers to Patent No. 1864, A.D. 1879); *Berichte*, 1881, xiv. 942. [From separate list.]

57. Nitroso-β-Naphthol-sulphonic Acid. (Preliminary note.) *Chem. News*, 1880, xlii. 175.

The first nitrososulphonic acid isolated. The amido-acid is "Eikonogen."

MISCELLANEOUS.

58. Inaugural Address to the Epping Forest and County of Essex Naturalists' Field Club, Feb. 28, 1880. *Transactions* of the Club, 1881, i. 3.

The laying down of the policy and line of work of the Club at its foundation.

59. Ice Filaments. *Nature*, 1879–80, xxi. 302.

1881.

60. Weismann's *Studies in the Theory of Descent* (1881–82).

Translated and edited with notes embodying some of my own observations; instigated the biological work of Poulton, who has founded the school of entomological bionomics at Oxford. Weismann's book first brought under my notice by Darwin, who wrote a Preface for the book. See Poulton's *Charles Darwin and the Theory of Natural Selection*, Cassell & Co., 1896, chap. xxv., from p. 204.

CHEMISTRY.

61. On a New Class of Colouring-Matters from the Phenols *Trans. Chem. Soc.*, 1881, xxxix. 37.

Continuation of the work recorded above (No. 56). The scientific study of the Oxazines was never completed by me, as Bernthien and Nietzki came into the field before I had time to continue the work. The β-naphthol colour was named "Meldola's Blue" in Germany, and was at one time manufactured on a large scale by Cassella & Co. of Frankfort and other firms.

62. On Nitroso-β-Naphthol-sulphonic Acid. *Ibid.*, 40.

Continuation of No. 57 above. The mixed iron salts of this acid were manufactured in Germany as "Naphthol Green B." The amido-acid was afterwards found to be a useful photographic developer and was manufactured under the name of "Eikonogen," (Andresen).

63. Ueber die Einwirkung des Benzylchlorids auf Diphenylamin. *Berichte*, 1881, xiv. 1385.

MISCELLANEOUS.

64. The Developmental Characters of the Larvæ of the Noctuæ as determining the Position of that Group. *Trans. Essex Field Club*, 1882, ii. 19.

65. Annual Presidential Address, Jan. 22, 1881. *Ibid.*, 1881, i. 97.

1882.

Chemistry.

66. Contributions to the Chemical History of the Aromatic Derivatives of Methane. *Trans. Chem. Soc.*, 1882, xli. 187.

Miscellaneous.

67. Mimicry between Butterflies of Protected Genera. *Ann. Mag. Nat. Hist.*, 1882, 5 ser., x. 417.

    A defence and general extension of the Müllerian theory of Mimicry, which was first brought under the notice of entomologists in this country by my translation of Müller's original paper in *Kosmos*, sent to me by Darwin [No. 54A]. The later developments of "Müllerian Mimicry" are due to Poulton and the Oxford School.

68. Preliminary Report, drawn up by W. Cole, of the Committee appointed to investigate the Ancient Earthwork in Epping Forest, known as the Loughton Camp. The work of a Committee consisting of General Pitt-Rivers, R. Meldola, and W. Cole. *Brit. Assoc. Rep.*, 1882, p. 274.

[68A. Annual Presidential Address to the Essex Field Club, Jan. 28, 1882. *Trans. Essex Field Club*, 1882, ii. 192.]

1883.

Chemistry.

69. On the Constitution of some Bromine Derivatives of Naphthalene (3rd notice). *Trans. Chem. Soc.*, 1883, xliii. 1.

70. The Action of Dibrom-naphthol upon Amines (preliminary notice). *Chem. News*, 1883, xlvii. 27.

71. On some Colouring Matters belonging to the Rosaniline Series. *Ibid.*, 133, 146.

    The discovery of the first naphthylated rosaniline; manufactured and introduced by Brooke, Simpson & Spiller.

72. Researches on Secondary and Tertiary Azo-Compounds. No. I. *Trans. Chem. Soc.*, 1883, xliii. 425. Also *Brit. Assoc. Rep.*, 1883, p. 455.

The discovery of the principle of alkaline reduction of nitro-group in para-position in nitroazo-compounds without reduction of the azo-group; aminoazo-compounds thus formed have been very largely used for the production of polyazo-compounds. This paper contains the first announcement of the possibilities of the method. See Bülow's *Chemische Technologie der Azofarbstoffe*, Leipzig, 1897.

MISCELLANEOUS.

73. Difficult Cases of Mimicry. *Nature*, 1882–83, xxvii. 482.

Further recognition of the principle (No. 22 [49]) that Natural Selection can act upon "faculty" as well as upon visible characters. [The subject of this letter is the mathematical aspect of the Müllerian theory of Mimicry.]

74. The Distribution of Abraxas ulmata. *Entomologist*, 1883, xvi. 236.

75. The Conservation of Epping Forest from the Naturalists' Standpoint. *Nature*, 1882–83, xxvii. 447.

76. "Decentralisation in Science." *Ibid.*, 1883, xxviii. 413.

77. Local Science Societies and the minor Prehistoric Remains of Britain. *Ibid.*, 1883–84, xxix. 19. Also abstract in *Brit. Assoc. Rep.*, 1883, p. 571.

A suggestion that the local societies should act as invigilators and should prepare maps of their own districts on which were recorded all the prehistoric remains. Afterwards taken up under the auspices of a survey committee started by the Society of Antiquaries.

78. Report, drawn up by W. Cole, of the Committee appointed to investigate the Ancient Earthwork in Epping Forest, known as the Loughton Camp. (Committee consisting of General Pitt-Rivers, Worthington Smith, R. Meldola, and W. Cole.) *Brit. Assoc. Rep.*, 1883, p. 243. See also *Trans. Essex Field Club*, 1884, iii. 212.

Extension of No. 68. (More work should be done in this earthwork; further sections required.)

79. Report of the "Local Scientific Societies" Committee. *Ibid.*, 318.

(H. G. Fordham was Secretary to this Committee, which led to the formation of the Corresponding Societies Rules of the British Association, drafted by Sir Francis Galton and others, with R. Meldola as first Secretary to the new Committee formed [in 1885] for carrying out this branch of the Association's work. Remained on this Committee till 1910.)

1884.

Chemistry.

80. Ueber eine neue Prüfungsmethode auf salpetrige Saüre. *Berichte*, 1884, xvii. 256.

    This reagent still appears to have a limited use. Its sensitiveness was tested by the late R. Warington in the Rothamsted Laboratory, and the results published.

81. Researches on Secondary and Tertiary Azo-Compounds. No. II. *Trans. Chem. Soc.*, 1884, xlv. 106.

82. On the Action of Dibrom-α-Naphthol upon Amines. *Ibid.*, 156. (Completion of No. 70.)

83. Note on the Constitution of the β-Azo-Compounds. *Chem. News*, 1884, l. 267.

Miscellaneous.

84. The Phosphorescence of the Jelly Fish. *Nature*, 1884, xxx. 289.

    Raises the question whether the phosphorescence in the case of "urticating" marine organisms may not be a "warning" character.

85. Nonagria sparganii, Esp. at Deal. *E.M.M.*, 1884–85, xxi. 135; *Entomologist*, 1884, xvii. 253.

    An early record of this as a British species; the moth was captured in a back garden at No. 7 Park Street, Deal, by my mother.

86. Darwin and Modern Evolution: Retiring Presidential Address to the Essex Field Club, Jan. 27, 1883. *Transactions*, 1884, iii. 59.

    An obituary notice of Darwin, who was the first Honorary Member of the Club.

87. The Remarkable Sunsets. *Nature*, 1883–84, xxix. 224.

1885.

Chemistry.

88. On the Constitution of the Haloïd Derivatives of Naphthalene (4th notice). *Trans. Chem. Soc.*, 1885, xlvii. 497; *Proc.*, 71, 74.

89. Researches on Secondary and Tertiary Azo-Compounds. (No. III.) *Ibid.*, *Trans.*, 657.
"Alizarine Yellow" of Meister, Lucius, etc. (See Grandmougin, *Berichte*, 1911, xliv. 3756.)

MISCELLANEOUS.

90. The Colours of Arctic Animals. *Nature*, 1884–85, xxxi. 505; 1885, xxxii. 172.
91. Colias edusa, Acherontia atropos, Sphinx convolvuli, and Chœrocampa celerio. *Entomologist*, 1885, xviii. 294.
92. The Lexden Earthquake. *Nature*, 1884–85, xxxi. 289.
93. Report on the East Anglian Earthquake of April 22, 1884. *Essex Field Club Special Memoirs*, vol. i. (1885). Written in conjunction with Wm. White.
93A. The Great Essex Earthquake, etc. *Trans. Herts. Nat. Hist. Soc.*, 1886, iv. 23. [From separate list.]
94. On some Geological Aspects of the East Anglian Earthquake of April 22, 1884. *Proc. Geological Assoc.*, 1885–86, ix. 20.
95. Review: *The Andaman Islanders*, by Man. *Nature*, 1885, xxxii. 409.
96. Telpherage. *Ibid.*, 1885–86, xxxiii. 12.
Written in conjunction with W. E. Ayrton as an account of the opening of the first telpherage line at Glynde, Sussex.
[96A. Report: On the Corresponding Societies. *Brit. Assoc. Rep.*, 1885, p. 708. Report of a Committee of which R. Meldola was Secretary.]

1886.

CHEMISTRY.

97. Note on the Constitution of the Naphthalene-derivatives. *Proc. Chem. Soc.*, 1886, ii. 172, 174.
98. The Scientific Development of the Coal Tar Colour Industry. *Journ. Soc. Arts*, 1885–86, xxxiv. 759.
A public warning [given May 13, 1886] as to the future decadence of the industry in this country through want of recognition of science by manufacturers. Also *Nature*, 1886, xxxiv. 324. The last paper read before the Chemical Section of the Society; see *Journ. Soc. Arts*, 1885–86, xxxiv. 855.

99. A Method of Investigating the Constitution of Azo- and Diazo-derivatives and Analogous Compounds. (With F. W. Streatfeild.) *Trans. Chem. Soc.*, 1886, xlix. 624; *Proc.*, 222.

The introduction of the method of alkylating diazo-amino-compounds, etc.

100. "Vermischte Notizen." *Berichte*, 1886, xix. 2683.

[Preparation of Dinitronaphthylamine : *m*-nitrophenylazodimethylamidobenzol.]

101. Ueber die Structur der Azo- und Diazoderivate. (With F. W. Streatfeild.) *Ibid.*, 3239. See No. 105.

MISCELLANEOUS.

102. Physiological Selection and the Origin of Species. *Nature*, 1886, xxxiv. 384.

A criticism of Romanes' theory.

103. Review: *Oils, Resins, and Varnishes*, by Cameron. *Ibid.*, 213.

104. Review: *Upland and Meadow*, by Abbott. *Ibid.*, 190.

[104A. Report: On the Corresponding Societies. *Brit. Assoc. Rep.*, 1886, p. 285. Report of a Committee of which R. Meldola was Secretary.]

1887.

CHEMISTRY.

105. Researches on the Constitution of Azo- and Diazo-derivatives. I. Diazoamido-compounds. (With F. W. Streatfeild). *Trans. Chem. Soc.*, 1887, li. 102; *Proc.*, 1886, ii. 263, 265.

106. Note on Wallach's Explanation of the Isomeric Transformation of Diazoamidobenzene into Amidoazobenzene. *Proc. Chem. Soc.*, 1887, iii. 27.

107. Researches on the Constitution of Azo- and Diazo-derivatives. II. Diazoamido-compounds (continued). (With F. W. Streatfeild.) *Trans. Chem. Soc.*, 1887, li. 434; *Proc.*, 50, 51.

108. Contributions to the Theory of the Constitution of the Diazoamido-compounds. *Phil. Mag.*, 1887, 5 ser., xxiii. 513.

A purely speculative note introducing the conception of tervalent phenyl group. Should not now accept proposed formulæ for these compounds, but think that tervalent phenyl may yet be justified in certain cases.

109. Notes on Anhydro-bases. I. Ethenyltriamidonaphthalene. (With F. W. Streatfeild.) *Trans. Chem. Soc.*, 1887, li. 691.

The first compound of this class in the naphthalene series. Has been since shown by Otto Fischer to belong to the class of "Oxyanhydro-bases." (See Nos. 271 and 404.)

MISCELLANEOUS.

110. London Lepidoptera. *Entomologist*, 1887, xx. 235.

111. The Manchester Meeting of the British Association. *Essex Naturalist*, 1887, i. 197.

Report as Delegate of the Essex Field Club.

[111A. Report: On the Corresponding Societies. *Brit. Assoc. Rep.*, 1887, p. 459. Report of a Committee of which R. Meldola was Secretary.]

1888.

CHEMISTRY.

112. Ueber den Ersatz der Amidogruppe durch die Acetylgruppe [Acetoxygruppe] mit Hülfe der Diazoreaction. (By an error of translation the title of the paper contains the term "Acetylgruppe.") *Berichte*, 1888, xxi. 601.

The first case of the synthesis of phenols by this method; afterwards followed up by Orndorff, etc., in America; the influence of light on the reaction afterwards shown by Orton. See G. M. Norman, *Trans. Chem. Soc.*, 1912, ci. Pt. II., 1913, and No. 114 below.

113. Note on Kjeldahl's Method for the Determination of Nitrogen. (With E. R. Moritz.) *Journ. Soc. Chem. Industry*, 1888, vii. 63.

114. Researches on the Constitution of Azo- and Diazo-derivatives. III. Compounds of the Naphthalene β-Series. (With F. J. East.) *Trans. Chem. Soc.*, 1888, liii. 460; *Proc.*, 47.

115. Researches on the Constitution of Azo- and Diazo-derivatives. IV. Diazoamido-compounds (continued). (With F. W. Streatfeild.) *Ibid.*, 664; *Proc.*, 63.

116. Some Amines and Amides derived from the Nitranilines. (With E. H. R. Salmon.) *Ibid.*, 774; *Proc.*, 87.

117. Evidence of the Tetravalency of Oxygen derived from the Constitution of the Azonaphthol-compounds. *Brit. Assoc. Rep.*, 1888, p. 635; *Phil. Mag.*, 1888, 5 ser., xxvi. 403.

A recognition of the possibility of quadrivalent oxygen existing in these compounds.

118. Azo-Colouring Matters. Thorpe's *Dictionary of Applied Chemistry*, vol. i. (1890), p. 234.

(Written 1888, published 1890.)

119. Review: *Watts' Dictionary of Chemistry*, new ed. by H. Foster Morley and M. M. Pattison Muir, vol. i., 1888. *Phil. Mag.*, 1888, 5 ser., xxvi. 73.

120. Review: *A Treatise on Alcohol*, by Stevenson. *Ibid.*, 76.

121. Reviews: *Elementary Chemistry*, by Muir and Slater; *Practical Chemistry*, by Muir and Carnegie; *Quantitative Analysis*, by W. N. Hartley. *Ibid.*, 230. [The last-named work was evidently by W. Dittmar, *ibid.*, 231. Hartley's book on the same subject (1887) was not reviewed in *Phil. Mag.*]

121A. Azo-Colouring Matters. *Watts' Dictionary of Chemistry*, vol. i., 1888, revised by Morley and Muir, p. 366. [From separate list.]

MISCELLANEOUS.

122. Emission of Scent by a Deltoid Moth. *Essex Naturalist*, 1888, ii. 113. Also *Nature*, 1888, xxxviii. 486.

Detection of odour from "fans" of H. tarsipennalis.

123. Lamarckism *v.* Darwinism. *Nature*, 1888, xxxviii. 388.

124. Report: On the present methods of teaching Chemistry. *Brit. Assoc. Rep.*, 1888, p. 73.

Work of a Committee of which W. R. Dunstan was Secretary.

[124A. Report: On the Corresponding Societies. *Ibid.*, 255. Work of a Committee of which R. Meldola was Secretary.]

125. Report: On the Prehistoric Inhabitants of the British Islands. *Ibid.*, 289.

Work of a Committee of which J. W. Davis was Secretary.

126. Report: On the advisability and possibility of establishing in other parts of the country observations upon the prevalence of Earth Tremors, etc. *Ibid.*, 522.

Report of a Committee of which G. A. Lebour was Secretary; the precursor of the Seismological Committee. (Some previous Reports of B.A. Committees on which I have served have not been catalogued, viz. 1884, 1885, 1886, and 1887.) [These references have now been added. The four Committees above named will be described henceforth as "Chemistry Teaching," "Corresponding Societies," "Brit. Prehist. Inhabitants," "Earth Tremors."]

1889.

CHEMISTRY.

127. The Separation of certain Red Shades of Acid Violet into Acid Magenta and Acid Violet. *Dyer and Calico Printer*, 1889, ix. 21 [see also p. 121]; *Journ. Soc. Dyers and Colourists*, 1889, v. 28; *The Textile Colourist*, 1889, xi. 79, 115.

128. Researches on the Constitution of Azo- and Diazo-derivatives. V. Compounds of the Naphthalene β-Series—continued. (With G. T. Morgan.) *Trans. Chem. Soc.*, 1889, lv. 114; *Proc.*, 11.

129. The Isomerism of the Alkyl-derivatives of Mixed Diazoamido-compounds. (With F. W. Streatfeild.) *Ibid.*, 412; *Proc.*, 98.

Recognition of the triple isomerism of these compounds.

130. Note on the oxidation of paradiamines. (With R. E. Evans.) *Proc. Chem. Soc.*, 1889, v. 115.

The proof that in the formation of quinone the amino-groups come out quantitatively in the form of ammonia.

131. The Molecular Weights of some Polymeric Compounds as determined by Raoult's Method. (With F. W. Streatfeild.) *Chem. News*, 1889, lx. 66.

132. Benzyl-derivatives of the Phenylenediamines. (With J. H. Coste.) *Trans. Chem. Soc.*, 1889, lv. 590; *Proc.*, 116.

133. Contributions to the Chemistry of the Azonaphthols. (With G. T. Morgan.) *Ibid.*, 603; *Proc.*, 127.

The first use of nitric acid as a means of determining the constitution of these compounds by "fission."

134. The Synthesis of Heterogeneous Mixed Alkyldiazoamidocompounds. *Ibid.*, *Trans.*, 610.

The mode of combination between the two isomerides which results in the formation of the third isomeride was unknown, but the facts were proved finally in this paper. It was suggested that the combination might be "molecular." It is now believed that the third isomeride is a "solid solution" of the two others. (See No. 148.)

135. Die Constitution der Azonaphthol Farbstoffe. *Die Farben-Industrie*, 1889, p. 185, (Erster Jahrgang).

A contribution to a new journal, published by Mayer & Müller in Berlin. Quadrivalence of oxygen advocated.

136. Note on Eikonogen, the new Photographic Developer. *Journ. Soc. Chem. Industry*, 1889, viii. 958.

A revision of the constitutional formula assigned in 1881 (No. 62).

137. The Chemistry of Photography. Published by Macmillan, 1889. *Nature Series.*

An attempt to put the teaching of photography as a technical subject on a scientific basis.

Miscellaneous.

138. Review: *Watts' Dictionary of Chemistry*, new ed., by Muir and Morley, vol. ii., 1889. *Phil. Mag.*, 5 ser., 1889, xxviii. 423.

139. Review: *Organic Chemistry*, by Bernthsen. *Ibid.*, 424.

140. The late Colonel Russell's Contributions to Photography, *Essex Naturalist*, 1889, iii. 117. Also *Photographic News*, 1889, xxxiii. 251, 286.

He was an Essex man, and one of the pioneers of dry-plate photography.

141. Technical Education for Chemists. Contribution to discussion in *Journ. Soc. Chem. Industry*, 1889, viii. 333.

142. The Floating Island in Lake Derwentwater. *Symons's Monthly Meteorological Mag.*, 1889, xxiv. 145.

An attempt to explain this phenomenon as due to subaqueous methane fermentation and accumulation of gas in vegetable mass.

143. Reports of Committees, *Brit. Assoc. Rep.*, 1889: Corresponding Societies (Secretary), p. 187; Chemistry Teaching, p. 288; Brit. Prehist. Inhabitants, p. 318.

1890.

Chemistry.

144. Synthesis of Triazine-derivatives. *Trans. Chem. Soc.*, 1890, lvii. 328; *Proc.*, 37.

A new synthesis from aldehydes and orthoamidoazo-compounds; discovered simultaneously by Goldschmidt and Rosell. (See Nos. 155 and 156 below.)

145. The Formation of Indene-derivatives from Dibrom-α-naphthol. (With F. Hughes.) *Ibid.*, 393; *Proc.*, 57.

Probably an error. Criticised by Liebermann, who considered the product to be a naphthaquinone derivative.

146. A Third Naphthaquinone. (With F. Hughes.) *Ibid.*, 631; *Proc.*, 88, 89.

The formula assigned—periquinone—is wrong. Afterwards shown to be a diquinone by Liebermann and myself. (See No. 255.)

147. The Photographic Image. Abstract of Friday Evening Discourse, May 16, 1890. *Proc. Royal Institution*, 1890–92, xiii. 134.

148. Researches on Normal and Mixed Diazoamides. (With F. W. Streatfeild.) *Trans. Chem. Soc.*, 1890, lvii. 785; *Proc.*, 139.

Completion of the proof of the existence of the three isomerides (No. 134).

149. Note on the Action of Nitric Acid on Dibrom-α-naphthol. (With F. Hughes.) *Ibid.*, 808; *Proc.*, 139.

Recognition of formation of brom-α-naphthaquinone as well as the new "quinone." (See No. 146.)

150. Diazoamido-Compounds: a Study in Chemical Isomerism, *Brit. Assoc. Rep.*, 1890, p. 780.

MISCELLANEOUS.

151. Review: *Mergui. Contributions to the Fauna of Mergui and its Archipelago*, Taylor and Francis. *Nature*, 1889–90, xli. 556.

152. Review: *A Hand-book of Photography*, by H. W. Vogel. *Ibid.*, 1890–91, xliii. 3.

153. Review: *Die photographische Retouche*, by Oppenheim. *Ibid.*, 55.

154. Reports in *Brit. Assoc. Rep.*, 1890, of same Committees as in 1889. [Corresponding Societies (Secretary), p. 55; Chemistry Teaching, p. 265; Brit. Prehist. Inhabitants, p. 548.]

1891.

CHEMISTRY.

155. Notes on the Azo-derivatives of β-Naphthylamine. (With F. Hughes.) *Trans. Chem. Soc.*, 1891, lix. 372; *Proc.*, 83.

Contains extension of Triazine synthesis (No. 144).

156. Researches in the Triazine Series. (With M. O. Forster; crystal measurements by W. J. Pope.) *Ibid.*, 678; *Proc.*, 123.

157. Photographic Chemistry. A course of three Cantor Lectures, delivered March 9, 16, and 23, 1891. *Journ. Soc. Arts*, 1890–91, xxxix. 787, 799, and 812.

158. Coal, and what we get from it. A Romance of Applied Science. *Romance of Science Series*, S.P.C.K., 1891.

A popular account of coal and coal-tar products. Expanded from the notes of a lecture delivered at the London Institution, Jan. 20, 1890.

159. Prefatory Notice. Streatfeild's *Practical Organic Chemistry*, E. & F. N. Spon, 1891.

MISCELLANEOUS.

159A. Essex and the Technical Instruction Act. *Nature*, 1890–91, xliii. 337. [From separate list.]

160. An Anti-Darwinian Contribution; review of *The Darwinian Theory of the Origin of Species*, by F. P. Pascoe. *Nature*, 1890–91, xliii. 409.

161. Co-adaptation. *Ibid.*, 557; 1891, xliv. 7, 28.

An attempt to show that the difficulty arising from "co-adaptation" urged by Spencer against the Darwinian theory is an imaginary one. Controversial with Romanes.

162. The Lepidoptera of Leyton and Neighbourhood: a Contribution to the County Fauna. *Essex Naturalist*, 1891, v. 153.

The preservation of a local list of captures while fresh in memory; of interest chiefly as relating to a district formerly rural, now urbanised.

163. Photography in Colours; review of *Photographie des Couleurs par la Méthode Interférentielle de M. Lippmann*, by Berget. *Nature*, 1891, xliv. 194.

164. Review: *A Summary of the Darwinian Theory*, by F. P. Pascoe. *Ibid.*, 247.

165. A Life of Darwin; review of *Charles Darwin: his Life and Work*, by C. F. Holder. *Ibid.*, 337.

166. An Evolutionary Castigation; review of *Science or Romance?*, by Rev. Father Gerard, S.J. *Ibid.*, 441.

167. Review; *Praktisches Taschenbuch der Photographie*, by E. Vogel. *Ibid.*, 1891–92, xlv. 51.

168. "Allotropic" Silver. *Chem. News*, 1891, lxiv. 283.

169. Reports of Committees, *Brit. Assoc. Rep.*, 1891. [Corresponding Societies (Secretary), p. 41; Application of Photography to Meteorology (henceforth "Photographic Meteorology"), p. 130; Earth Tremors, p. 333; Brit. Prehist. Inhabitants, p. 449.]

1892.

Chemistry.

170. Ethylene derivatives of diazoamido-compounds. (With F. W. Streatfeild.) *Proc. Chem. Soc.*, 1892, viii. 119.

171. A method for determining the number of NH_2 groups in certain organic Bases. (With E. M. Hawkins.) *Ibid.*, 133.

Introduction of the method based on conversion of diazo- into triazo-groups.

172. Some Homonucleal Tri-derivatives of Naphthalene. (With C. H. Desch.) *Trans. Chem. Soc.*, 1892, lxi. 765; *Proc.*, 141.

Miscellaneous.

173. Photography as a Branch of Technology; Address to the Royal Photographic Society, Feb. 19, 1892. *Trans. Photograph. Soc. Grt. Brit.*, 1891–92, xvi. 152; *Nature*, 1891–92, xlv. 331.

An attempt to bring about the establishment of a phototechnical institute; emphasis laid on the prevalence of low-grade quality of technical education in the country. (See article by Kershaw, *Monthly Review*, 1901, iv. 37 (July number)).

174. Reports of Committees, *Brit. Assoc. Rep.*, 1892. [Corresponding Societies (Secretary), p. 29; Photographic Meteorology, p. 77; Earth Tremors, p. 343.]

175. Agricultural Education; Speech in Colchester Town Hall. *East Anglian Daily Times*, June 6, 1892, p. 7.

First attempt to bring about centralisation of technical education by means of "whiskey money," as against policy of diffusion and smattering.

176. Pigments of Lepidoptera. *Nature*, 1891–92, xlv. 605.

177. Prof. Lippmann's Colour Photographs. *Times*, 1892, July 18, p. 3, and July 27, p. 3.

A defence of the method against certain criticisms.

178. Coal-Tar Colouring-Matters; review of *Tabellarische Uebersicht, etc.*, by Schultz and Julius. *Nature*, 1892, xlvi. 313.

179. A Modern Revival of Prout's Hypothesis; review of a paper by H. Wilde. *Ibid.*, 568.

180. Review: *Principles of Chemistry*, by Mendeléeff. *Phil. Mag.*, 1892, 5 ser., xxxiv. 301.

181. Review: *The Study of Animal Life*, by J. A. Thomson. *Ann. Mag. Nat. Hist.*, 1892, 6 ser., x. 328.

182. Review: *Watts' Dictionary of Chemistry*, new ed. by Morley and Muir, vol. iii. (1892). *Phil. Mag.*, 1892, 5 ser., xxxiv. 454.

183. Review: *Organic Dyestuffs*, by Nietzki (Collin & Richardson). *Ibid.*, 448.

184. Arborescent Frost Patterns. *Nature*, 1892–93, xlvii. 125.

A remarkable case of constrained crystallisation of water (mud) on London pavements; much correspondence followed.

1893.

Chemistry.

185. The Action of Nitrous Acid on 1-α-amido-2-β-naphthol: a correction. *Proc. Chem. Soc.*, 1892, viii. 218 (in No. 117, published Jan. 3, 1893).

186. The preparation of dinitro-α-naphthylamine, etc. (With M. O. Forster.) *Ibid.*, 1893, ix. 7.

187. Note on a meta-azo-compound. (With F. B. Burls.) *Ibid.*, 126.

188. Azo-compounds of the Ortho-Series. (Pt. I. with E. M. Hawkins; Pt. II. with F. B. Burls.) *Trans. Chem. Soc.*, 1893, lxiii. 923, 930; *Proc.*, 161.

The first discovery of the four products of reduction of acylated azo-naphthol derivatives.

189. Some Peri-derivatives of Naphthalene. (With F. W. Streatfeild.) *Ibid.*, 1054; *Proc.*, 199.

190. Oxazines. Article in Thorpe's *Dictionary of Applied Chemistry*, vol. iii. (1893), p. 79. [Also "Primuline," p. 309.]

MISCELLANEOUS.

191. Reports of Committees, *Brit. Assoc. Rep.*, 1893. [Corresponding Societies (Chairman), p. 35; Photographic Meteorology, p. 140; Earth Tremors, p. 287; Action of Light on Dyed Colours (henceforth "Light Action on Dyes"), p. 373; Ethnographical Survey of British Islands (henceforth "Brit. Ethnograph. Survey"), p. 621.]
192. Review; *Odorographia*, by Sawer. *Phil. Mag.*, 1893, 5 ser., xxxv. 73.
193. Tinctorial Art and Science; review of *A Manual of Dyeing*, by Knecht, Rawson, and Loewenthal. *Nature*, 1893, xlviii. 170.
194. Review: *Arbeitsmethoden für Organisch-chemische Laboratorien*, by Lassar-Cohn. *Phil. Mag.*, 1893, 5 ser., xxxvi. 547.
195. November Raspberries. *Symons's Monthly Meteorological Mag.*, 1893, xxviii. 171.
196. Colias edusa, etc., in South Devon. *Essex Naturalist*, 1893, vii. 125.
197. Some Additions to the List of the Lepidoptera of the Epping Forest District. *Ibid.*, 128.
An extension of No. 162 above.

1894.

CHEMISTRY.

198. Azo-p-cresol derivatives. (With F. Southerden.) *Proc. Chem. Soc.*, 1894, x. 118.
199. Notes on meta-azo-compounds. (With E. S. Hanes.) *Ibid.*, 140.
200. Azo-compounds of the Ortho-Series. Pt. III. (With E. S. Hanes.) *Trans. Chem. Soc.*, 1894, lxv. 834; *Proc.*, 175.
201. Notiz über Paradinitrodiazoamidobenzol. (With F. W. Streatfeild.) *Berichte*, 1894, xxvii. 2201.
202. Photographic Chemistry. Article in *Watts' Dictionary of Chemistry*, Muir and Morley, vol. iv. (1894), p. 154.

MISCELLANEOUS.

203. Reports of Committees, *Brit. Assoc. Rep.*, 1894; Committees as in No. 191, in same order; pp. 19, 143, 145, 238, 419.

204. An Antivivisectionist Failure. *Brit. Medical Journ.*, 1894, i. 28.

The antivivisectionists had failed to compel the Society for Promoting Christian Knowledge to withdraw Percy Frankland's book from their *Romance of Science* Series.

205. Epping Forest. *Times*, 1894, March 31, p. 16.

First move towards checking the unreasonable public agitation against the necessary thinning out of old pollards. Led to series of organised meetings, and first general discussion on the whole question opened by me at the special meeting of the Essex Field Club convened for the purpose; the tide of public opinion was turned. See *Essex Naturalist*, 1894, viii. 52-71.

206. The Settlement of the Epping Forest Question. *Nature*, 1894, l. 225.

A notice of the Report of the Special Commissioners appointed by the Corporation of London as result of above agitation.

207. Review: *Systematic Survey of the Organic Colouring Matters*, by Schultz and Julius (A. G. Green). *Ibid.*, 267.

208. Review: *The Optics of Photography;* review of *Das Licht im Dienste der Photographie und die neuesten Fortschritte der photographischen Optik*, by H. W. Vogel. *Ibid.*, 589.

209. Reviews: *Watts' Dictionary of Chemistry*, new ed. by Muir and Morley, vol. iv. (1894); *The Scientific Basis of Analytical Chemistry*, by Ostwald; *Select Methods in Chemical Analysis*, by Crookes, 3rd ed. *Phil. Mag.*, 1894 [1895], 5 ser., xxxix. 138, 225, 305.

210. Xanthia ocellaris at Twickenham. *E.M.M.*, 1894, xxx. 161.

The first record of this species as British; simultaneous note published by C. G. Barrett.

1895.

Chemistry.

211. Isomeric Dinitrodiazoamidobenzenes and their Melting-points. (With F. W. Streatfeild.) *Trans. Chem. Soc.*, 1895, lxvii. 50; *Proc.*, 1894, x. 230.

212. The action of nitrous acid on dibromaniline, etc. (With E. R. Andrews.) *Proc. Chem. Soc.*, 1895, xi. 109.

213. Homonucleal Tri-derivatives of Naphthalene. (With F. W. Streatfeild.) *Trans. Chem. Soc.*, 1895, lxvii. 907; *Proc.*, 159.

214. The State of Chemical Science in 1851; Presidential Address to Section B, British Association, Ipswich Meeting, Sept. 12, 1895. *Brit. Assoc. Rep.*, 1895, p. 639. See also No. 395.

Miscellaneous.

215. Reports of Committees, *Brit. Assoc. Rep.*, 1895; Committees as in No. 191, in same order; pp. 39, 80, 184, 263, 509.

216. The Eastern Boundary Stones of the Forest of Waltham. *Essex Naturalist*, 1895–96, ix. 1.

An archæological discovery leading to the re-erection of the stones by the Essex Field Club, by means of a grant from the Essex County Council, in 1908. (See No. 375.)

217. Epping Forest: an Explanation. *Nature*, 1895, lii. 81.

218. The Management of Epping Forest. *City Press*, May 29, 1895, p. 5.

219. Curious Aerial or Subterranean Sounds. *Nature*, 1895–96, liii. 4.

1896.

Chemistry.

220. The Alkaline Reduction of Metanitraniline. (With E. R. Andrews.) *Trans. Chem. Soc.*, 1896, lxix. 7; *Proc.*, 1895, xi. 214.

Contains speculations with respect to the mechanism of reduction of nitro- to amino-group, which have since been verified.

221. Mixed diazoamides containing an orthonitro-group. (With F. W. Streatfeild.) *Proc. Chem. Soc.*, 1896, xii. 49.

A case of "steric hindrance."

222. Allyl-p-dinitrodiazoamidobenzene : a study of the relations between melting-point and constitution. (With F. W. Streatfeild.) *Ibid.*, 51.

223. Mononitroguaiacol. *Ibid.*, 125.

The first mononitroguaiacol obtained. The constitution (guessed) has been subsequently revised from 4-nitro- to 5-nitro-compound.

224. Contributions to the Chemistry of Phenol Derivatives. (With G. H. Woolcott and E. Wray.) *Trans. Chem. Soc.*, 1896, lxix. 1321 ; *Proc.*, 163.

MISCELLANEOUS.

225. Reports of Committees, *Brit. Assoc. Rep.*, 1896. [Corresponding Societies (Chairman), p. 31 ; Photographic Meteorology, p. 172 ; Seismological Investigation (henceforth "Seismology"), p. 180 ; Light Action on Dyes, p. 347 ; Green's "Coccidæ of Ceylon," p. 450 ; British Ethnograph. Survey, p. 607.]

226. Becquerel and Lippmann's Colour Photographs. *Nature*, 1896, liv. 28.

227. The Work of Local Societies. *Ibid.*, 114.

228. August Kekulé ; Obituary Notice. *Ibid.*, 297.

229. A Visit to an English Woad Mill. (With Francis Darwin.) *Ibid.*, 1896–97, lv. 36.

Account of a visit to the woad mill near Wisbech, and description of the method of cultivation, etc.

230. Technical Education ; Address at Barking at the annual prize distribution at the Technical Institute by the Countess of Warwick on Nov. 11, 1896. *Nature*, 1896–97, lv. 69 ; full report in *Essex Times*, Nov. 14, p. 8.

A further plea for centralisation of, and systematic organised curriculum for, day classes in rural schools. Led to foundation of the agricultural school at Bigods, near Dunmow. (See Nos. 251 316, and 360.)

231. Review: *A Handbook of Industrial Organic Chemistry*, by Sadtler. *Technical World*, March 14, 1896, vi. 395.

232. Review: *Chemistry for Engineers*, vol. i., by Blount and Bloxam. *Ibid.* [continued, from March 28, 1896, as *Education*], May 2, 1896, n. ser., i. 72.

233. Artificial Colouring Matters; review of *Matières Colorantes organiques artificielles*, by Lefêvre. *Nature*, 1895–96, liii. 603.

234. The Speculative Method in Entomology; Annual Presidential Address to the Entomological Society of London, Jan. 15, 1896. *Proc. Ent. Soc.*, 1895, p. xlviii.

An attempt to break down the prejudice against the "scientific use of the imagination" among pure systematists. Also *Nature*, 1895–96, liii. 352.

235. Wasps and Flies. *Nature*, 1896, liv. 576.

An observation of wasps cutting off wings of house flies and carrying away the bodies.

236. The Utility of Specific Characters. *Ibid.*, 594; 1896–97, lv. 29.

Discussion of Weldon's biometric work.

1897.

MISCELLANEOUS.

237. Evidence on Teaching of Chemistry in London given before a Committee of the Education Committee of the London County Council. *London Technical Education Gazette*, 1897, iii. 20.

[237A. On the Rationale of Chemical Synthesis; read in opening discussion at combined meeting of Sections I and K, Aug. 24, 1897. *Brit. Assoc. Rep.*, 1897, pp. 826, 866. Title only.]

238. Review; *Chemistry for Engineers*, vol. ii., by Blount and Bloxam. *Technical World* [*Education*, see No. 232], 1897, n. ser., ii. 156.

239. The Teaching of Chemistry. *Times*, 1897, Feb. 17, p. 4.

240. Inflammable Hair-wash. *Ibid.*, 1897, Aug. 10, p. 10.

241. A Philosophical Theory of Selection; review of *Versuch einer philosophischen Selektionstheorie*, by Johannes Unbehaun. *Nature*, 1897, lvi. 49.

242. [An inadvertent repetition of No. 240.]

243. Review; *The Principles of Chemistry*, by Mendeléeff, new ed., 1897. *Phil. Mag.*, 1897, 5 ser., xliv. 514.

244. Reports of Committees, *Brit. Assoc. Rep.*, 1897. [Corresponding Societies (Chairman), p. 23; Photographic Meteorology, p. 128; Seismology, p. 129; Light Action on Dyes, p. 286; Brit. Ethnograph. Survey, p. 452.]

245. Editor's Preface to *Steam Boilers*, by G. Halliday.

Inauguration of a new series of *Practical Science Manuals*, published by Arnold.

246. The Utility of Specific Characters and Physiological Correlation; Annual Presidential Address to the Entomological Society of London, Jan. 20, 1897. *Proc. Ent. Soc.*, 1896, p. lxiv.

An attempt to show that, in discussing "utility" from the Darwinian standpoint, physiological correlation must rank with other and more visible external characters.

1898.

Chemistry.

247. Contributions to the Chemistry of Phenol Derivatives; II. (With F. H. Streatfeild.) *Trans. Chem. Soc.*, 1898, lxiii. 681; *Proc.*, 165.

248. Paranitro-orthoanisidine. *Proc. Chem. Soc.*, 1898, xiv. 226.

249. Editor's Preface to *Chemistry for Agricultural Students*, by T. S. Dymond. *Practical Science Manuals*. Arnold.

Miscellaneous.

250. Reports of Committees, *Brit. Assoc. Rep.*, 1898; Committees as in No. 244, in same order; pp. 41, 283, 179, 285, 712.

251. Scientific Education in Rural Districts. An address at the opening of the Technical and Agricultural School founded by the Countess of Warwick at Bigods, Dunmow, Essex, delivered July 29, 1898. Reported in the Essex Press, and also privately printed. Outcome of Barking address (No. 230; see No. 360).
252. The Hope Museum at Oxford; review of *The Hope Reports*, vol. i., edited by E. B. Poulton. *Nature*, 1897–98, lvii. 289.
253. Museums; review of *Essays on Museums and other Subjects connected with Natural History*, by Sir Wm. Flower. *Nature*, 1898, lviii. 217.
254. Scientific Education in Rural Districts. (With the Countess of Warwick.) *Ibid.*, 1898–99, lix. 7.

1899.

Chemistry.

255. Ueber das Naphtochinon aus Dibrom-α-naphtol. *Berichte*, 1899, xxxii. 868.

    Recognition of this compound as a diquinone. (See No. 146.)

256. Amidoamidines of the Naphthalene Series. (With P. P. Phillips.) *Trans. Chem. Soc.*, 1899, lxxv. 1011; *Proc.*, 187.
257. Notes on polyazo-compounds. (With W. A. Williams.) *Proc. Chem. Soc.*, 1899, xv. 196.

    Discovery of method of "fission" of azo-compounds by sulphuric acid and a bichromate. (See No. 346.)

Miscellaneous.

258. Reports of Committees, *Brit. Assoc. Rep.*, 1899; Committees as in No. 244, in same order; pp. 27, 238, 161, 363, 493.
259. The Training of Chemical Engineers. *Journ. Soc. Chem. Industry*, 1899, xviii. 339.
260. Science and Agriculture. *Woman's Agricult. Times*, vol. i. No. 1, p. 14, July 1899.

261. A Plea for Rural Secondary Education. (With the Countess of Warwick.) *East Anglian Daily Times*, Aug. 12, 1899, p. 3.

262. Rural Education. *Nature*, 1899, lx. 616; 1899–1900, lxi. 55.

263. An Evolutional Polemic; review of *Organic Evolution Cross-examined; or, Some Suggestions on the Great Secret of Biology*, by the Duke of Argyll. *Nature*, 1898–99, lix. 217.

Controversial against "internal developmental forces."

264. The Duke of Argyll and Mr Herbert Spencer. *Ibid.*, 269, 317.

Correspondence with Spencer [and the Duke] arising from above review.

265. Technical Chemists as "Made in Germany"; founded on *Chemische Technologie an den Universitäten und technischen Hochschulen Deutschlands*, by Ferdinand Fischer. *Nature*, 1898–99, lix. 361.

Led to action by President of the Society of Chemical Industry (Beilby); *Journ.*, 1899, xviii. 333. [See above, No. 259.] See also Bashford, *Fortnightly Review*, Oct. 1905, lxxxiv. 696.

266. A Science of the Sciences; review of *Groundwork of Science*, by St George Mivart. *Nature*, 1898–99, lix. 577.

267. Mimicry and Warning Colours. *Ibid.*, 1899, lx. 55.

A notice of Poulton's paper on Mimicry, etc., *Journ. Linnean Soc.: Zool.*, 1898, xxvi. 558.

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A popular account of protective resemblance and mimicry. [With a portrait of the author.]

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1900.

Chemistry.

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Recognition of the isomerism of the products formed by different reducing agents. (See No. 109.)

272. Note on the Elimination of a Nitro-group during Diazotisation. (With E. Wechsler.) *Ibid.*, 1172; *Proc.*, 167.

The first recorded case of this reaction. (See Nos. 296 and 297.)

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Miscellaneous.

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278. Ennomos alniaria, Leucania vitellina, Plusia festucæ, and Pieris daplidice at Bognor. *Ibid.*, 306.

279. Vanessa antiopa in Essex. *Ibid.*, 354.

280. Caradrina ambigua at Pagham. *Ibid.*, 355.

281. Agricultural Education; speech on a Deputation to the Duke of Devonshire organised by the Agricultural Education Committee. *County Council Times*, 1900, xxiii. 63.

282. The Education of the Farmer's Son and Daughter. *Woman's Agricult. Times*, vol. i. No. 10, April 1900.

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A suggestion for testing inheritance of acquired characters.

291. The Correspondence of Berzelius and Schönbein ; review of *The Letters of Jöns Jacob Berzelius and Christian Friedrich Schönbein*, 1836–1847 ; ed. by G. W. A. Kahlbaum ; translated by F. V. Darbishire. *Ibid.*, 1900–01, lxiii. 77.

292. Chemical Products and Appliances at the Paris International Exhibition. *Ibid.*, 179.

293. A Contribution to Lamarckian Evolution ; review of *Sexual Dimorphism, etc.*, by J. T. Cunningham. *Ibid.*, 197.

294. Sexual Dimorphism. *Ibid.*, 252, 299.

Controversy with Cunningham arising from above review.

1901.

CHEMISTRY.

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The first systematic account [April 17, 1901] in this country of the new process for synthesising indigo; criticism of supineness of indigo planters and their neglect of science. Prompted action by Indian Government and Indigo Planters' Association. See W. P. Bloxam's *Report to the Government of India containing an Account of the Research Work on Indigo performed in the University of Leeds, 1905–1907*; India Office, 1908. Led to a further report from me to the Indian Government Advisory Committee of the Royal Society, and embodied in their Report to the India Office in 1909. See also F. M. Perkin in *Journ. Roy. Soc. Arts*, 1914–15,, lxiii. 117, and discussion.

296. The diazotisation of dinitroanisidine and the constitution of the resulting product. (With J. V. Eyre.) *Proc. Chem. Soc.*, 1901, xvii. 131. (See No. 272; also Klemenc in *Berichte*, 1914, xlvii. 1407.)

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MISCELLANEOUS.

298. Reports of Committees, *Brit. Assoc. Rep.*, 1901. [Seismology, p. 40; Age of Stone Circles, p. 427; Corresponding Societies, p. 465.]

299. Note on the *Specimen Courses of Object Lessons on Common Things, etc., for Rural Schools*, by the Board of Education. *Nature*, 1900–01, lxiii. 603.

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302. Science Teaching in Schools of Science. *Warwick Advertiser*, May 11, 1901, p. 3 [see also pp. 5, 6].

Relates to the opening of King's Middle School.

303. The Raid upon the New Forest Flora. *Times*, 1901, June 5, p. 11 [strongly supported in Leading Article, p. 9]; *Nature*, 1901, lxiv. 126.

304. Reports upon the Exhibits of Class 87 (Applied Chemistry and Pharmacy), Paris Exhibition of 1900. (With W. Douglas Hogg.) *Report of His Majesty's Commissioners*, 1901, ii. 211.

305. Alkaloids; review of *Die Pflanzen-Alkaloide*, by J. W. Brühl, E. Hjelt, and Ossian Aschan. *Nature*, 1900–01, lxiii. 486.

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307. Review: *Annals of Politics and Culture*, by Gooch. *Ibid.*, 53.

308. Instruction in Village Schools; reviews of *Rural Readers* and *The Teacher's Manual*, *etc.*, by V. T. Murché. *Ibid.*, 394.

309. A Modern Text-book of Chemistry, vol. vii. Pt. v., and vol. viii. Pt. vi., Brunswick, 1899–1901; review of the German edition of Roscoe and Schorlemmer's *Chemistry*, edited by J. W. Brühl. *Ibid.*, 1901–02, lxv.; Supplement, p. iii, to No. of Nov. 14, 1901.

310. Technical Schools for Rural Districts. *Ibid.*, 1901–02, lxv. 106.

311. A Periodical for Statistical Biologists; review of Part I. of *Biometrika*. *Ibid.*, 106.

312. The Courtship of Anthocharis cardamines. *Entomologist*, 1901, xxxiv. 128.

313. Butterflies in London Parks. *Nature*, 1900–01, lxiii. 592.

1902.

Chemistry.

314. Elimination of a Nitro-group on Diazotisation. Dinitro-*p*-Anisidine and Derivatives. (With J. V. Eyre.) *Trans. Chem. Soc.*, 1902, lxxxi. 988; *Proc.*, 160.

[314A. A New Method of causing Isomerisation. *Brit. Assoc. Rep.*, 1902, p. 587. Title only.]

MISCELLANEOUS.

315. Reports of Committees, *Brit. Assoc. Rep.*, 1902; Committees as in No. 298, in same order; pp. 59, 455, 857 [851].

316. Pioneer Work in Secondary and Technical Education in Rural Districts; an address delivered at the Conference of Science Teachers, Jan. 10, 1902. *London Technical Education Gaz.*, 1902, viii. 48; *Woman's Agricult. Times*, vol. iii. No. 10, April 1, 1902.

Refers to the foundation by the Duchess of Sutherland of a school at Golspie, Sutherland, on lines of Bigods School. (See Nos. 230, 251, and 336.)

317. The Coming of Age of the Essex Field Club: a Record of Local Scientific Work; 1880–1901. Annual Presidential Address, delivered at 22nd Annual Meeting, March 22, 1902. *Essex Naturalist*, 1901–02, xii. 73.

A *résumé* of the Club's work during twenty-one years.

318. Report of evidence given by me, Feb. 10, 1902, before the Special Sub-Committee of the L.C.C. Technical Education Board, on the Relation of Science to Industry; *London County Council Report*, p. 25.

319. The Royal Commission on Coal Supply. *Times*, 1902, Jan. 7, p. 8.

A suggestion that the terms of reference should be enlarged so as to include economisation of consumption, smoke prevention, etc.

320. Frost Patterns. *Nature*, 1901–02, lxv. 222. A recurrence of No. 184.

321. Nature Study in Schools; notice of first issue of *Nature Study Journal*. *Ibid.*, 369.

322. Quantitative Investigations of Biological Problems; notice of Part II. of *Biometrika*. *Ibid.*, 521.

323. The Evolution of Life; review of *L'Évolution de la Vie*, by Laloy. *Ibid.*, Supplement, p. viii, to No. of April 24, 1902.

324. Evolution and Design ; review of *The Lesson of Evolution*, by Hutton. *Ibid.*, 1902, lxvi. 219.

325. Statistical Methods in Biology ; notice of Part III. of *Biometrika*. *Ibid.*, 234.

326. The Struggle for Life ; Mimetic Insects. *Pall Mall Mag.*, 1902, xxviii. 43.

A popular article.

327. Can Carbon Dioxide be "Vitalised"? *Nature*, 1902, lxvi. 492.

328. The Completion of Roscoe and Schorlemmer's *Organic Chemistry*. *Ibid.*, 546.

Refers to completion of German edition by Brühl and colleagues.

329. Mohr on the Dynamical Theory of Heat and the Conservation of Energy ; review of *Die Entwicklung unserer Naturanschauung in XIX. Jahrhundert und Friedrich Mohr*, by Ch. Jezler. *Ibid.*, 1902–03, lxvii. Supplement, p. v, to No. of Nov. 6, 1902.

330. Mimetic Insects ; abstract of Friday Evening Discourse delivered at the Royal Institution on June 7, 1901. *Proc. Roy. Inst.*, 1899–1901, xvi. 693.

331. Plusia moneta in Surrey. *Entomologist*, 1902, xxxv. 244.

1903.

Chemistry.

332. A Contribution to the Radium Question. *Times*, 1903, Aug. 29, p. 9.

A suggestion that radium consisted of an endothermic compound of radium with helium, made before constant evolution of heat had been measured.

(Should no longer maintain this view, since it has been shown that the rate of disintegration is not changed by application of heat.) Attributed to Armstrong by Mellor in his *Inorganic Chemistry* of 1913.

333. Isomeric Aminoamidines of the Naphthalene Series. (Fourth communication on Anhydro-bases.) (With J. V. Eyre and J. H. Lane.) *Trans. Chem. Soc.*, 1903, lxxxiii. 1185 ; *Proc.*, 205.

334. The Relations between Scientific Research and Chemical Industry; lecture at University Extension meeting, Oxford, Aug. 3, 1903. *Nature*, 1903, lxviii. 398. Reprinted in abstract by *Brit. Journ. Photography*, 1903, l. 714, 733, 750, and by *Journ. Soc. Arts*, Sept. 4, 1903, li. 808.

MISCELLANEOUS.

335. Reports of Committees, *British Assoc. Rep.*, 1903. [Seismology, p. 77; Corresponding Societies, p. 465.]

336. A Technical School for the Highlands of Scotland. *Nature*, 1903, lxviii. 497.

Relates to the opening of the Duchess of Sutherland's Technical School at Golspie. (See No. 316.)

337. The Holy Shroud of Turin; review of *Le Linceul du Christ; Étude scientifique*, and *The Shroud of Christ*, by P. Vignon. *Ibid.*, 1902–03, lxvii. 241.

Gave rise to much correspondence: T. G. Bonney, *ibid.*, 296; General Waterhouse, *ibid.*, 317, 345; Worthington G. Smith, *ibid.*, 317; R. E. Froude, *ibid.*, 367.

338. Review: *Notions fondamentales de Chimie organique*, by Moureu. *Ibid.*, 269.

339. Bird Protection and Flower Persecution. *Times*, 1903, Feb. 14, p. 8.

A plea for the more efficient protection of our wild flowers, even common ones.

340. Insect Periodicity; Maximum and Minimum Periods. *Entomologist*, 1903, xxxvi. 17.

1904.

CHEMISTRY.

341. The Chemical Synthesis of Vital Products and the Interrelations between Organic Compounds. Vol. i., Arnold, 1904.

342. The Isomerism of the Amidines of the Naphthalene Series. (Fifth communication on Anhydro-bases.) (With J. H. Lane.) *Trans. Chem. Soc.*, 1904, lxxxv. 1592; *Proc.*, 214, 215.

MISCELLANEOUS.

342A. Reports of Committees, *Brit. Assoc. Rep.*, 1904. [Seismology, p. 41 ; Corresponding Societies, p. 377.]

343. Colouring Matters, Artificial and Natural; review of Schultz's *Systematic Survey of the Organic Colouring Matters*, by A. G. Green ; 2nd ed. *Nature*, 1903–04, lxix. 529.

344. Odoriferous Substances used in Perfumery ; review of *Die Riechstoffe*, by Cohn. *Ibid.*, 1904, lxx. 597.

345. Review : *A Scheme for the Detection of the more common Classes of Carbon Compounds*, by Weston. *Ibid.*, 1904–05, lxxi. 175.

1905.

CHEMISTRY.

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347. Note on β-NH-Ethenyldiaminonaphthalene. (With J. H. Lane.) *Proc. Chem. Soc.*, 1905, xxi. 24.

348. Dinitroanisidines and their Products of Diazotisation. (With F. G. C. Stephens.) *Trans. Chem. Soc.*, 1905, lxxxvii. 1199 ; *Proc.*, 218.

349. Evidence on the use of Industrial Alcohol given before the Departmental Committee, Nov. 29, 1904. *Report of the Industrial Alcohol Committee*, presented to Parliament, 1905, p. 55.

Statement of the early history of the coal-tar colour industry in England, showing that at this period the decline of the industry was not connected with the restrictions upon the use of alcohol.

MISCELLANEOUS.

350. The late Prof. Tacchini. *Nature*, 1904–05, lxxi. 583.

An appreciation.

351. The Bates-Müller Hypothesis of Mimicry ; a Question of Historical Accuracy. *Ibid.*, 1905–06, lxxiii. 100.

Correction of an error of the late A. S. Packard's.

352. Reports of Committees, *Brit. Assoc. Rep.*, 1905. [Corresponding Societies, p. 35; Seismology, p. 83.]

352A. The Times of Appearance of Lepidoptera in connection with Season and Latitude. *Entomologist*, 1905, xxxviii. 90.

1906.

Chemistry.

353. The Living Organism as a Chemical Agency; a Review of some of the Problems of Photosynthesis by Growing Plants. Annual Presidential Address to the Chemical Society, March 30, 1906. *Transactions*, 1906, lxxxix. 745.

354. Note on 4-bromo-2-nitro 1(α)-naphthylamine. (With H. G. Dale.) *Proc. Chem. Soc.*, 1906, xxii. 156.

355. Dinitroanisidines and their Products of Diazotisation. (Second communication.) (With F. G. C. Stephens.) *Trans. Chem. Soc.*, 1906, lxxxix. 923; *Proc.*, 157.

See also Reverdin in *Berichte*, 1914, xlvii. 2216.

356. Notes on Derivatives of α-N-Alkylated Naphthylamine. *Trans. Chem. Soc.*, 1906, lxxxix. 1434; *Proc.*, 245.

357. A New Trinitroacetaminophenol and its use as a Synthetical Agent. *Ibid.*, 1935; *Proc.*, 303.

The discovery of an extremely active "mobility" in a nitro-group.

Miscellaneous.

358. Chemistry in Rural Schools. *Nature*, 1905–06, lxxiii. 558.

359. American Chemists and the Jubilee of the Coal-Tar Colour Industry. *Ibid.*, 1906, lxxiv. 514.

360. Bigods School; a letter on the closing of the School through lack of support by the Board of Education and the Essex County Council. *Essex County Chronicle*, July 20, 1906, p. 8 [see also p. 5]; *East Anglian Daily Times*, July 20, p. 5, etc.

361. Jubilee of the Discovery of Mauve and of the Foundation of the Coal-Tar Colour Industry by Sir W. H. Perkin.

Edited with A. G. Green and J. C. Cain. *Report of Proceedings*; published by the Perkin Memorial Committee through the *Times* Office. Speech, at the banquet, July 26, 1906, on present position of the Industry; *Report*, p. 47.

362. Reports of Committees, *Brit. Assoc. Rep.*, 1906. [Corresponding Societies, p. 45; Seismology, p. 92.]

1907.

Chemistry.

363. The Position and Prospects of Chemical Research in Great Britain; Annual Presidential Address to the Chemical Society on March 22, 1907. *Trans. Chem. Soc.*, 1907, xci. 626.

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364. The Diazotisation of Dinitroanisidines and Related Compounds. (With J. G. Hay.) *Ibid.*, 1474; *Proc.*, 211.

Miscellaneous.

365. The Scientific Training of the Pharmacist; Inaugural Address at the opening of the Session of the School of Pharmacy on Sept. 30, 1907. *Pharmaceutical Journ.*, 1907, 4 ser., xxv. 428.

366. Fecundity of the Leopard Moth. *Nature*, 1907, lxxvi. 382.

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1908.

Chemistry.

368. Syntheses with Phenol Derivatives containing a Mobile Nitro-group; Part I. The Interaction of 2 : 3 : 5-Trinitro-4-acetylaminophenol and Amines. (With J. G. Hay.) *Trans. Chem. Soc.*, 1908, xciii. 1659; *Proc.*, 197. (Continuation of No. 357.)

369. A molecular compound of trinitroacetylaminophenol and β-naphthol. (With J. G. Hay.) *Proc. Chem. Soc.*, 1908, xxiv. 210.

MISCELLANEOUS.

370. Sparrows as Moth Catchers. *Entomologist*, 1908, xli. 228.

371. Colias edusa in Dorset. *Ibid.*, 251.

372. Noctua ditrapezium a Scotch species. *Ibid.*, 273.

374. [No. 373 inadvertently omitted.] The Founding of the Coal-tar Colour Industry; Annual Presidential Address to the Society of Dyers and Colourists at Bradford, April 3, 1908. *Journ. Soc. Dyers and Colourists*, 1908, xxiv. 95.

An account of Perkin's technological work.

375. The Eastern Boundary Stones of the Forest of Waltham. Supplementary Note. *Essex Naturalist*, 1907–08, xv. 126.

An extension of No. 216 arising from the re-erection of the stones by the Essex Field Club and the Essex County Council.

376. The Chemistry of the Higher Fungi; review of *Chemie der höheren Pilze, eine Monographie*, by J. Zellner. *Nature*, 1907–08, lxxvii. 553.

377. A Contribution to the Indigo Question; review of Bloxam's Report to the Indian Government referred to under No. 295. *Ibid.*, 1908, lxxviii. 296.

Reply to criticism by the Behar Indigo Planters' Association. *Ibid.*, 540.

378. William Henry Perkin; Obituary Notice. *Proceedings of the Royal Society*, vol. lxxx. A, 1907–08, p. xxxviii; also (with No. 374) *Trans. Chem. Soc.*, 1908, xciii. 2214, and (Abstract) *Berichte*, 1911, xliv. 911.

379. Reports of Committees, *Brit. Assoc. Rep.*, 1908. [Seismology, p. 60; Corresponding Societies, p. 536.]

379A. The Old-Street Tram-Car Accident. *Times*, 1908, Sept. 26, p. 3. [From separate list.]

1909.

Chemistry.

380. A New Isomer of Picric Acid. *Journ. Soc. Dyers and Colourists*, 1909, xxv. 12.

381. Syntheses with Phenol Derivatives containing a Mobile Nitro-group. Part II. The Interaction of 2 : 3 : 5-Trinitro-4-acetylaminophenol and Amines (continued). (With J. G. Hay.) *Trans. Chem. Soc.*, 1909, xcv. 1033; *Proc.*, 167.

382. 2 : 3 : 5-Trinitro-4-aminophenol and Derivatives. (With J. G. Hay.) *Ibid.*, 1378; *Proc.*, 207.

Miscellaneous.

383. Education and Research in Applied Chemistry; Annual Presidential Address to the Society of Chemical Industry, London, May 26, 1909. *Journ. Soc. Chem. Ind.*, 1909, xxviii. 554.

384. Deferred Emergence of Eupithecia togata. *Entomologist*, 1909, xlii. 182.

385. Cucullia umbratica a Fertilizer of Orchis maculata. *Ibid.*, 281. (See also *ibid.*, 1910, xliii. 106, for illustration.)

386. Notes from Inverness-shire, 1909. *Ibid.*, 283.

387. Orthochromatic Photography. *Times*, 1909, May 7, p. 9.

A reclamation on behalf of the late Prof. H. Vogel of Berlin.

388. Evolution: Old and New; review of *Darwin and Modern Science*, the Darwin Jubilee Cambridge Memorial Volume. *Nature*, 1909, lxxx. 481.

389. The Species Question re-opened; review of *The Making of Species*, by Dewar and Finn. *Ibid.*, 1909, lxxxi. 481.

390. The "Origin of Species" and its Lessons; review of *Charles Darwin and The Origin of Species*, by Poulton. *Ibid.*, 1909–10, lxxxii. 91.

391. Reports of Committees, *Brit. Assoc. Rep.*, 1909. [Seismology, p. 48; Corresponding Societies, p. 325.]

1910.

Chemistry.

392. Salts and Ethers of 2 : 3 : 5-Trinitro-4-Acetylaminophenol. (With H. Kuntzen.) *Trans. Chem. Soc.*, 1910, xcvii. 444 ; *Proc.*, 58.

393. The Products of Diazotisation of the Trinitro-*p*-anisidines. (With F. Reverdin.) *Ibid.*, 1204 ; *Proc.*, 132.

394. Complete methylation by methyl sulphate. *Proc. Chem. Soc.*, 1910, xxvi. 232. (See No. 414.)

395. The First Synthesis of Ethyl Alcohol. *Journ. Soc. Chem. Industry*, 1910, xxix. 737.

A claim for priority on behalf of Hennell; an extension of a statement in Ipswich Address (No. 214). See *Le Moniteur Scientifique-Quesneville*, for October, 1912, p. 638.

396. Tinctorial Chemistry: Ancient and Modern. Annual Presidential Address to the Society of Dyers and Colourists at Manchester, March 18, 1910. *Journ. Soc. Dyers and Colourists*, 1910, xxvi. 103.

See paper by J. Hübner, *ibid.*, 1913, xxix. 344.

Miscellaneous.

397. Late Emergence of Plusia gamma. *Entomologist*, 1910, xliii. 33.

398. Ortholitha cervinata and Polia flavicincta in the Epping Forest District. *Ibid.*, 119.

399. Aerial Navigation. *Times*, 1910, Sept. 16, p. 6, and Sept. 30, p. 10.

Discovery of a prophetic passage by Erasmus Darwin.

400. Research and Industry. *Yorkshire Observer*, Bradford, Nov. 11, 1910; see leading article in same issue and subsequent correspondence ; also *Nature*, 1910–11, lxxxv. 94, and *Report of the Technical Education Committee* of the British Science Guild, *Fifth Annual Report*, 1911, pp. 78–81. [With reprint of letter of Nov. 11, the leading article and later correspondence. Professor Meldola was Chairman of the Technical Education Committee, and

the whole of his Appendix (*Ibid.*, pp. 72–81) is devoted to "Research in Relation to Technical Education."]

A general plea for technical research scholarships.

401. Evolution, Darwinian and Spencerian; the Herbert Spencer Lecture delivered at Oxford, Dec. 8, 1910. Oxford University Press. [Abstract in *Nature*, 1910–11, lxxxv. 220.]

402. Reports of Committees, *Brit. Assoc. Rep.*, 1910. [Seismology, p. 44; Corresponding Societies, p. 311.]

1911.

Chemistry.

403. Syntheses with Phenol Derivatives Containing a Mobile Nitro-group. Part III. Complex Iminazoles, Azo-compounds, and Azides. (With H. Kuntzen.) *Trans. Chem. Soc.*, 1911, xcix. 36; *Proc.*, 1910, xxvi. 340.

404. The question of isomerism between naphthiminazoles. *Proc. Chem. Soc.*, 1911, xxvii. 98.

405. Syntheses with Phenol Derivatives Containing a Mobile Nitro-group. Part IV. Quinone-imides, Asymmetric Quaternary Ammonium Compounds, and Asymmetric Carbinols. (With H. Kuntzen.) *Trans. Chem. Soc.*, 1911, xcix. 1283; *Proc.*, 157.

406. Syntheses with Phenol Derivatives Containing a Mobile Nitro-group. Part V. Quinone-imides, Asymmetric Quaternary Ammonium Compounds, and Asymmetric Carbinols (continued). (With H. Kuntzen.) *Ibid.*, 2034; *Proc.*, 263.

Miscellaneous.

407. What has become of the British Satyridæ? *Entomologist*, 1911, xliv. 146.

408. A Contribution to the History of Evolution; review of *The Coming of Evolution*, by J. W. Judd. *Nature*, 1910–11, lxxxv. 297.

409. Julius Wilhelm Brühl; obituary notice. *Ibid.*, 517.

410. Rudolf Fittig; obituary notice. *Trans. Chem. Soc.*, 1911, xcix. 1651.

411. Report of Committee on Seismology. *Brit. Assoc. Rep.* 1911, p. 30. [Meldola continued on this Committee till the end of his life. *Ibid.*, 1912, p. 69 (No. 429); 1913, p. 45 (No. 439); 1914, p. 41; 1915, p. 52.]

1912.

Chemistry.

412. Introductory Note to *Practical Chemistry for Engineering Students*, by A. J. Hale, B.Sc. Longmans, 1912.

413. Introduction to *Bleaching and Dyeing of Vegetable Fibrous Materials*, by J. Hübner, M.Sc. Constable, 1912.

414. Quinone-Ammonium Derivatives. Part I. The Methylation Products of Picramic and *iso*-Picramic Acids. (With W. F. Hollely.) *Trans. Chem. Soc.*, 1912, ci. 912; *Proc.*, 128. (See No. 394 above.)

415. *Iso*-Picramic Acid and its Use as an Indicator. (With A. J. Hale and H. V. Thompson.) *Chemical World*, 1912, i. 327 (Oct. No.).

Miscellaneous.

416. Glazed Frost; a Reminiscence. *Nature*, 1911–12, lxxxviii. 447; see also pp. 516 and 550.

417. International Association of Chemical Societies. *Ibid.*, 1912, lxxxix. 245.

[417A. Contributed a short statement to a Conference of the Fellows and Associates of The Institute of Chemistry on the remuneration and conditions of public chemical appointments, held on June 21, 1912. Professor Meldola was unable to attend owing to illness. *Report of Conference*, published by The Institute of Chemistry, July, 1912, pp. 3–5.]

418. An attempt to colonize Papilio machaon in Essex. *Entomologist*, 1912, xlv. 8.

419. The Summer of 1911 and the present Season. *Ibid.*, 155.
420. West Surrey Lepidoptera. *Ibid.*, 184.

1913.

Chemistry.

421. Chemistry. *Home University Library.* Williams & Norgate (undated).
422. Quinone-ammonium Derivatives. Part II. Nitro-haloid, Dihaloid, and Azo-compounds. (With W. F. Hollely.) *Trans. Chem. Soc.*, 1913, ciii. 177 ; *Proc.*, 6.
423. An Attempted Photochemical "Resolution" of Silver. *Nature*, 1913, xci. 109.
424. The Absorption Spectra of Some Derivatives of the Nitro-aminophenols in Relation to their Constitution. (With J. T. Hewitt.) *Trans. Chem. Soc.*, 1913, ciii. 876; *Proc.*, 160.
425. The Constitution of the Trinito-*p*-aminophenols and Trinitro-*p*-anisidines. (With F. Reverdin.) *Ibid.*, *Trans.*, 1484 ; *Journal für praktische Chemie*, new ser., 1913, lxxxviii. 785 ; *Bulletin de la Société Chimique de France*, 1913, 4 ser., xiii. 981.

Miscellaneous.

426. Presidential Address to The Institute of Chemistry of Great Britain and Ireland, Annual Meeting, March 3, 1913. *Proceedings*, 1913, Part II. p. 9.

[426A. Inaugurated a Conference of Professors of Chemistry to consider the general question of the training of chemists, held at The Institute of Chemistry on October 17, 1913. Professor Meldola prepared a preliminary statement as a basis for discussion, presided at the Conference, and contributed to the discussion which followed. *Report of Conference*, published by The Institute of Chemistry, November, 1913, pp. 3–8, 28–32, 77.]

427. Papilio xuthus at Woking. *Entomologist*, 1913, xlvi. 247.

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428. The Natural History of a London Suburb; review of *Hampstead Heath: Its Geology and Natural History*, The Hampstead Scientific Society. *Nature*, 1913–14, xcii. 137.

429. Report (Seismological Investigations). *Brit. Assoc. Rep.*, 1912, p. 69.

430. Mutilla europæa in Yorkshire. *Entomologist*, 1913, xlvi. 316.

1914.

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[440A. Alkylated Para-phenylenediamines and Derivatives. Quinoneimide-Ammonium Compounds. (With W. F. Hollely.) *Trans. Chem. Soc.*, 1915, cvii. 610.]

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[440B. National Dye Industry. *Times*, 1915, Jan. 20, p. 9.]
[440C. Address of the Retiring President to The Institute of Chemistry of Great Britain and Ireland, March 1, 1915, *Proceedings*, 1915, Pt. II. p. 9. See also the account of Professor Meldola's term of office, with a portrait, in *History of The Institute of Chemistry*, by R. B. Pilcher, 1914, pp. 251–82.]

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[An asterisk indicates that the publication is in the form of a book.]

1.* Elementary Inorganic Chemistry. Murby, 1873. [No. 32 of the Chronological List.]

2. Organic Chemistry. *Encyclopædia Britannica*, 9th ed., vol. v. (1876), p. 544. [No. 45.]

3.* Studies in the Theory of Descent, by August Weismann. Translated and edited with notes. Sampson Low, 1882. [No. 60.]

4.* Report on the East Anglian Earthquake of April 22, 1884. By R. Meldola and W. White. Macmillan, 1885. [No. 93.]

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7.* The Chemistry of Photography. Macmillan & Co., 1889. [No. 137.]

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[Many other publications in the Chronological List might be appropriately added here, notably the presidential addresses and the public statements which have initiated valuable movements or started important discussions.]

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Marchant, James, 1867-1956, ed.

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"Bibliography of works": p. 174-225.
1. Meldola, Raphael, 1849-1915

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